CERN
CH1211 Geneva 23
Switzerland
CH1211 Geneva 23
Switzerland

Engineering Department

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FUNCTIONAL SPECIFICATION

The EAST AREA modifications in LS 1

DIRAC replacement by Proton and Mixed Field Irradiation Facilities plus other consolidation work

DOCUMENT PREPARED BY:	DOCUMENT CHECKED BY:	DOCUMENT APPROVED BY:
Markus Brugger, Lau Gatignon, Michael Lazzaroni, Federico Ravotti	Robert Froeschl, Maurice Glaser, Andre Henriques, Julien Mekki, John Pedersen, Andrea Polato, Marc Tavlet	Simon Baird, Ilias Efthymiopoulos

HISTORY OF CHANGES

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0.0	2013-06-30	26	First draft, following several preceding documents

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1. Introduction

1.1 General description

The East Area has been operating for many years with aging equipment, high failure rates and high dose levels. A consolidation program for the whole of the East Area has been proposed in two phases. The first phase will take place in 2013-2014 during Long Shutdown 1. The DIRAC experiment is being dismantled and a new irradiation facility, combining a proton irradiation facility and a mixed field facility, will be installed in the old DIRAC location. Such an irradiation facility at CERN is necessary to test and validate detectors for the experiments (LHC and others) and complete electronics systems as well as individual electronics components for accelerators (R2E).

The advantages of such a new facility are numerous. As the facility has no more competition for protons from the DIRAC experiment, more protons can be made available for irradiations. On top of that in many cases the same protons can be shared between the proton and mixed field facilities. More space and shielding will be available and the irradiation areas will be equipped with a state-of-the-art ventilation system. The layout can be optimised to reduce doses to the personnel during the interventions. The increased space also allows irradiating larger objects, even in operation with services (e.g. cooling, ventilation) connected. Access will only stop the facility itself, not the beam to the other East Area users such as the test beams and the CLOUD experiment. The facility is urgently required for the R2E project.

1.2 Brief description of the installation

The facility is composed of a proton irradiation facility upstream and a mixed field facility downstream. The proton facility contains 3 groups of mobile tables that may receive objects to be irradiated. Typically the higher-Z material objects are irradiated on the downstream tables. Small objects can be inserted on the beam line remotely via a 'shuttle' that positions the objects in a location in between the first and second group of tables. The beam then continues through a separation volume towards the mixed field facility further downstream. In the mixed field facility the beam impinges on a target, which produces a high-radiation field around it. Four mobile shielding plates allow modulating the radiation field in a calibrated way to reproduce the field that objects (e.g. electronics cards) would receive at specific locations inside the LHC tunnel and shielded areas and its injector chain, as well as radiation fields relevant for space and surface applications.

Both irradiation areas will be ventilated with a small filtered air recirculation during operation (at least 300 m^3 per hour). Before access the air will be renewed 3 times during a ~30 minutes long flush at up to 5000 m^3 per hour. The areas should be air tight with leaks of the order of 1 volume per hour or less.

Access to the facility goes via a single PAD/MAD access door that leads into a common service space. From there two sector doors, each with the possibility of receiving a RP veto, give access to the respective facilities. A third volume, the hot buffer zone, is protected from the beam and is available to receive irradiated objects for cool-down before they can be removed from the facility. This volume, like the corridors between the volumes, is not ventilated.

In the mixed field facility very significant efforts are made to minimise the radiation doses for the personnel intervening. During each access the mixed field target will be moved into a separate area that will be closed off by sliding marble doors. The mobile shielding plates will be moved into the shield between the proton and mixed field facilities. All cabling to the equipment will be done outside the mixed field target chamber, at a location near its entrance called 'loading area', where the dose to the personnel will be limited by a shielding door. From there the equipment, with the cables attached, will be moved in place with a remotely controlled conveyor system.

In the proton facility the option to irradiate equipment in a cryostat will be foreseen. A transfer line to the North side allows a dewar to be located (and filled) in a freely accessible area downstream of the T9 zone.

1.3 Other consolidation activities

In the shadow of the modifications outlined above, some independent consolidation work and modifications will take place in the East Hall. At the time of writing the two cranes have been renovated and slightly upgraded in capacity from 20 to 25 tons for PR67 [1] and from 40 to 45 tons for PR39 [2]. Also the DIRAC experiment, the old irradiation facility and the T7 beam line and experimental area have been dismantled. The foreseen works include the replacement of splitter magnet F61.SMH1 by a MCB-type magnet, the replacement of the marguerite targets, beam stopper consolidation and the implementation of the Cesar beam control system for the secondary beams and replacing the working sets and knobs.

Following the results of the magnet patrol, magnet repairs may turn out to be necessary in addition to the repair of F61N.DVT01.

In parallel, the replacement of the primary zone access doors by new PAD/MAD doors will take place. This is managed by PS-PSS project [3] in the GS department, but closely coordinated with the other works in the building, which are described in the present document.

2. The new irradiation facilities

Both irradiation facilities, the proton facility and the mixed field facility are served by the same primary proton beam line, the T8 beam derived from a slow extraction from the PS via the F61 and F61S transfer lines. In this chapter we describe in more detail the beam line and the facilities, as well as the associated infrastructure.

2.1 The beam line

The beam line is unchanged in the present upgrade and consolidation program. The only small adaptation is a minor change in the vacuum layout downstream of the last quadrupole ZT8.QFO02 and the final beam stoppers. The detailed layout of the beam line is described in the Beatch file available in [4].

The T8 beam itself is a slowly extracted primary proton beam of 24 GeV/c and with a maximum intensity of 5 10^{11} protons per spill of about 400 msec. In [5] we describe the detailed characteristics of the beam line, including different focussing options. The maximum proton flux we can imagine to achieve technically is 6.7 10^{10} protons per second on average, leading to 10^{18} protons per year. The design of the shielding and ventilation systems is based on these intensities, but in practice the intensities will be below these values by a significant factor (typically 3 to 5 times lower) due to sharing of protons with other users of the PS complex and the user requirements which are usually lower than this maximum. The beam line settings used for DIRAC correspond rather precisely to a waist at the location of the shuttle in the proton irradiation facility.

2.2 General description of the proton irradiation facility

The proton facility is installed in the old DIRAC target zone, just after the last beam line elements. It replaces the old facility, which was located next to the T7 beam line, which has been dismounted in the first half of 2013. The ventilation of the new zone will be described in chapter 3.

A layout of the proton irradiation facility is shown in Figure 1.

Three groups of mobile tables allow to position samples on the beam line or close to it. A maximum of 3 tables per group can be installed in parallel. Access to these tables requires access to the facility and thus stopping the T8 beam line. The low-Z samples will be irradiated on the upstream table, the highest-Z samples downstream.

Further downstream, a position has been reserved for a cryostat filled with liquid Helium or Nitrogen. The cryogenic liquid is provided from a dewar located outside the irradiation zone, in a freely accessible area downstream of the T9 beam line. The cryogenic transfer line connecting the dewar to the cryostat will be permanently installed.

A shuttle allows the positioning of smaller samples directly from the control room onto the beam line without accessing the irradiation zone.

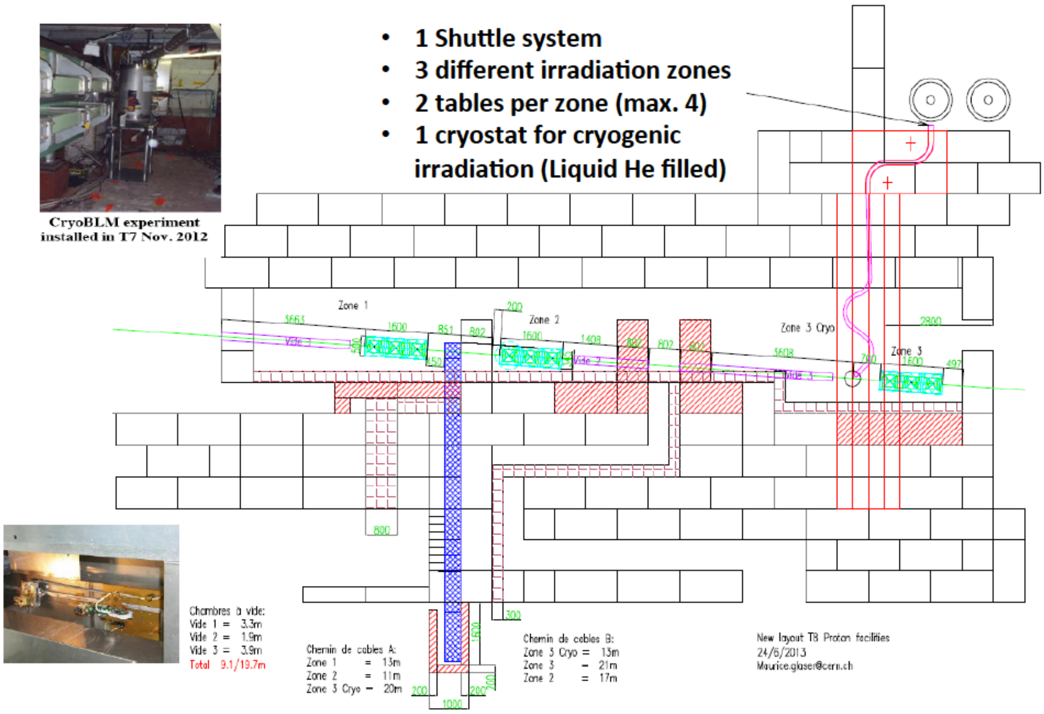

Figure 1 — Layout of the proton irradiation facility

2.3 General description of the mixed field area

The layout of the mixed field area is shown in Figure 2.

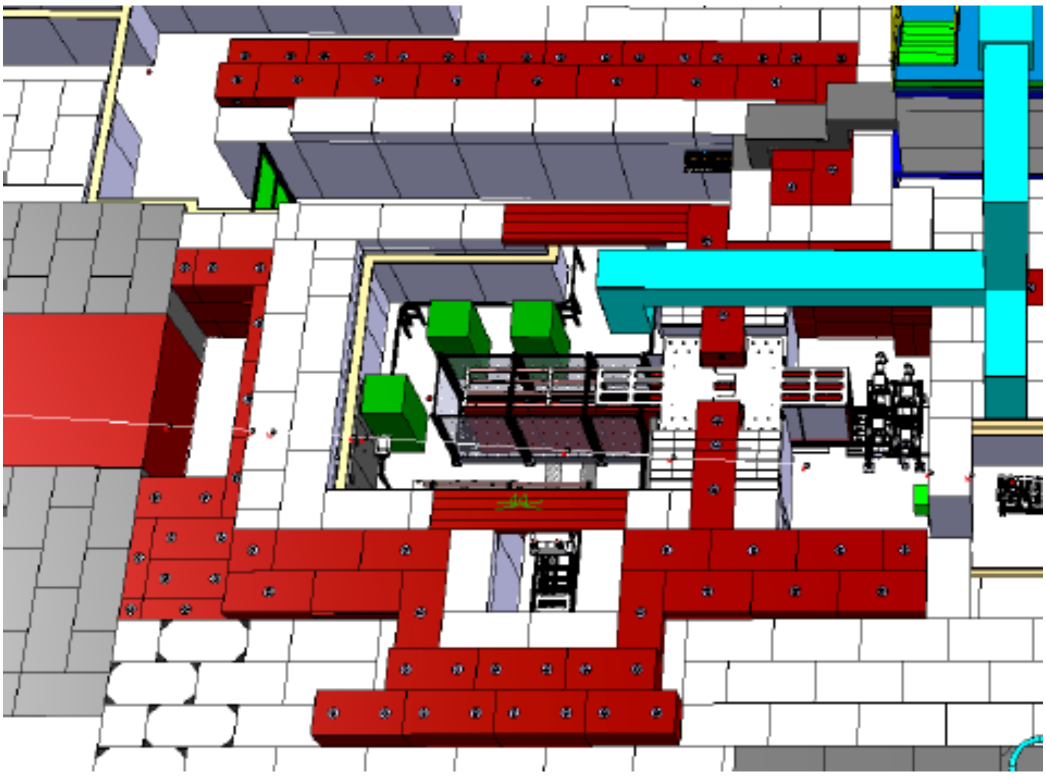

Figure 2 — Layout of the mixed field area

The protons that have traversed the proton irradiation area will impinge on a target that generates an intense radiation field. The intensity of the radiation field can be modulated by the choice of target head, e.g. two massive ones (Al or Cu) or one with holes, such that only part of the primary beam interacts in the target. The yield of the massive Al target is about 2.5 times smaller than for the massive Cu target, whereas the Aluminium target with holes gives an additional reduction by a factor of 4 (thus a factor 10 in total). Four mobile shielding plates allow further modulation of the field. The field configurations are known by FLUKA simulation [6] and will be validated by measurement during the commissioning of the facility.

Depending on the precise location in the mixed field facility, the radiation field is representative of the one that electronics is exposed to around the LHC tunnel and shielded areas, in equivalent areas in the CERN injector chain, as well as in certain space or other applications. Moreover, in the proton facility (or also in the downstream facility without target) detectors can be exposed directly to the proton beam, which will create higher intensities and thus radiation effects (e.g. displacement damage) similar to the ones in the LHC experiments or to accelerator components installed close to the beam.

Typically a year of exposure in the LHC could be simulated in one or a few weeks in this facility. The size of the available test area is such that also larger objects can be irradiated and ultimately even objects in operation with services (power, cooling, etc.) connected.

A lot of attention will be paid to minimisation of the radiation doses to the personnel that has to intervene in this facility. The roof and walls of the facility will be covered with marble, thus reducing the induced activity. Before each access the mobile shielding plates will be moved into a shielded position and the target itself moved out of he area into the ‘mixed field target storage zone’ and hidden behind sliding marble doors. After irradiation, activated objects can be stored temporarily for cool-down in the ‘Hot buffer area’. See Figure 3.

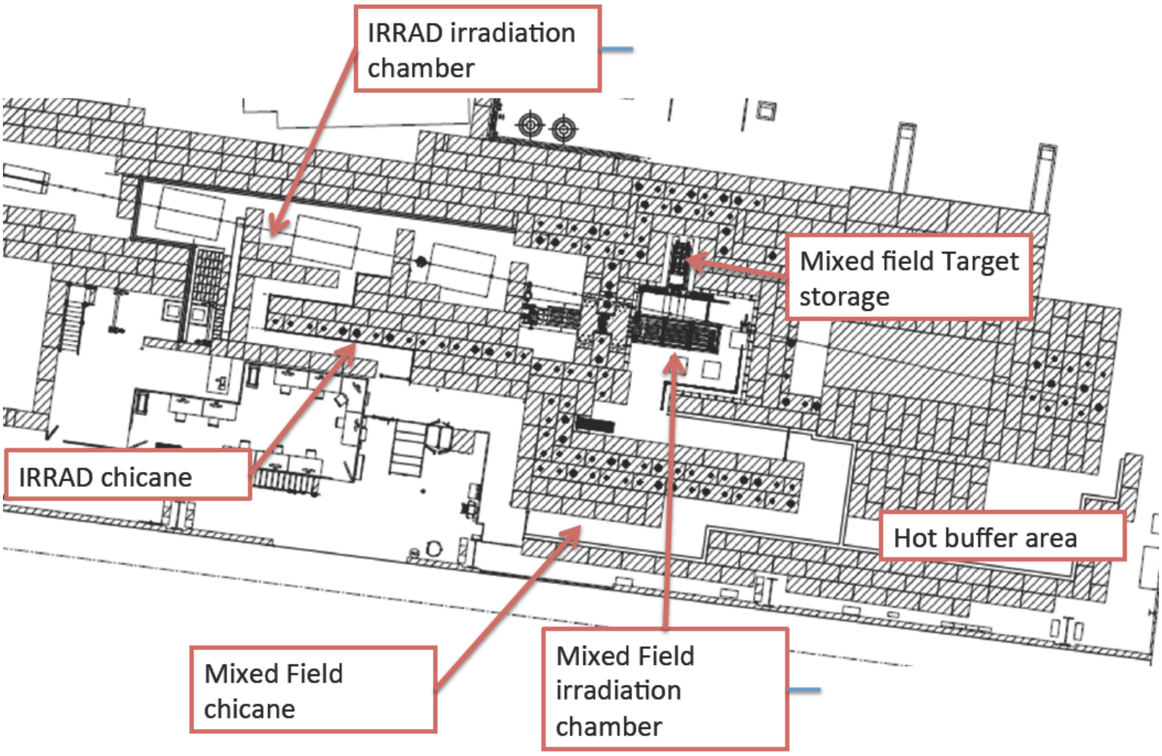

Figure 3 — The various volumes in the facility

3. Infrastructure description

3.1 General building infrastructure

The East Area is located in Building 157 and covers a surface of ~110 by 44 m^2. Some services, like power converters of the magnets, are installed in neighbouring auxiliary buildings 251 and 263. The present modifications concern mainly the south half of the building, where the DIRAC experiment, as well as the T7 beam line, experimental area and irradiation facility were located. During this phase of the project the general infrastructure and the building itself will not be affected. The only building modification is the installation of an additional escape door on the East wall.

3.2 Dismantling activities

The DIRAC experiment has been dismantled in the beginning of 2013. In Figure 4 we show a view of the DIRAC experiment when its roof shield was removed, in Figure 5 a picture taken at the end of April 2013. The dismantling has been a combined effort of the DIRAC team, who dismounted their detectors and put them in storage, the magnet team in PH/DT and the various services in the ATS sector, in particular the transport teams.

Figure 4 — A view of the DIRAC experiment before the start of dismantling

At the same time the T7 beam line, experimental area and the old irradiation facilities have been dismantled, including the old shuttle systems.

The amount of waste was rather small, as most of the DIRAC detectors as well as the various magnets (beam line and spectrometers) will be preserved for future use. The detectors were mostly measured to be non-radioactive (the only exception being the small drift chambers on the beam) and could be stored in building 185.

Figure 5 — A view of the same zone by mid June 2013

3.3 Cranes

Both cranes in B157 have been consolidated and upgraded from 20 to 25 (PR67) and from 40 to 45 tons (PR39) respectively.

The span is 40.7 m for both and the hook height is 9.3 m for PR67 and 9.4 m for PR39. For both cranes the lifting speed can vary from 0.1 to 10 m/minute, the crane travel speed from 1 to 20 m/minute and the trolley speed from 1 to 10 m/minute. Data sheets of both cranes are available on EDMS, see [1] and [2].

3.4 Layout and shielding of zones

The layout of the irradiation zones is shown in Figures 1 and 2 and the naming of the different volumes is shown in Figure 3. Access to the proton and mixed field zone is via a common PAD/MAD access door. Via two sector doors access is possible to the two separate zones. There is a possibility to put a RP veto individually on each of the doors. We anticipate that in general a RP veto will only be applied to the mixed field area door. Access to the mixed field area will also give access to the hot buffer area where irradiated equipment can be stored temporarily for radiation cool-down. The buffer tone is locked by a separate door (not in the access chain).

The corridors from the sector doors to the irradiation volumes follow a chicane such as to minimize the leakage of radiation (in particular neutrons) via these passages. In the passage to the mixed field area an airtight ventilation door isolates the corridor and hot buffer area from the irradiation zone from the ventilation point of view. At the end of the corridor passing the hot buffer zone an emergency exit will be installed.

The proton irradiation zone will contain 3 groups of mobile tables allowing the precise positioning of samples on or close to the beam axis. The low-Z materials will be irradiated on the upstream table, the highest Z materials on the third table. The shielding has been design according to this strategy.

In the mixed field facility the proton beam will impinge on a target that produces the wanted radiation field. Mobile shielding plates allow modulation of the field according to the requirements of the main users. The target can be massive for maximum radiation field intensity or with holes to allow for lower intensity. In the proton facility (and to a lesser extent also in the mixed field facility) the beam focusing allows to vary the effective radiation field.

The layout of the shielding and corridors has been simulated in detail with FLUKA, both for the proton [7] and mixed field [6] parts of the facility. These simulations have validated the adequateness of the shielding design and serve also as basis for the design of the ventilation systems. As input for the simulations the maximum proton flux reasonably possible has been assumed, knowing that the real fluxes will in general be lower by a factor of 3 to 5 at least.

Especially in the mixed field facility precautions have been taken to minimize the radiation dose to persons intervening. Before access the target will be moved into the mixed field target storage, see Figure 3, which will be closed off by two 20 cm thick marble doors. The mobile shielding plates will be moved upstream into their parking position, i.e. behind the shielding. Installation of equipment inside the target chamber will be mostly automatized with remote controlled conveyors. The cabling of the equipment will be performed in the loading area, situated outside the target chamber itself. The walls and ceiling will be covered with marble plates, thus minimizing residual dose during access. Before access the air volume will be flushed 3 times (also in the proton irradiation area).

3.5 Beam instrumentation

At the upstream end of the proton irradiation area a SEC monitor (secondary emission counter) will measure the proton flux and TV screens allow monitoring the beam position and size. Up to four different screens can be made available and they will be mounted on a linear movement system that replaces the old marguerite (see section 4.4). This system allows also the positioning of targets on a different movement. However, in general an empty position will be used in this case.

At each group of tables, a dedicated Beam Profile Monitor (BPM) will be installed by the users. The information from these monitors will be made available to the CCC. Similarly, the beam intensity and profile will be measured just upstream of the mixed field target.

3.6 Proton facility tables and shuttle

In the proton irradiation area, the particle beam impinges directly on the samples to be tested. The samples are installed and positioned in the proton beam by using two different types of holders: the tables and the shuttle [8].

The tables are remote-controlled stages providing the possibility to position the samples with ±0.1mm precision in the transversal plane (X-Y) with respect to the beam axis. The tables also rotate over the azimuthal angle (θ) in order to achieve a precise alignment with the beam within ±0.025º. The prototype of an irradiation table is shown in Figure 6. The installation of the samples on the table requires the access to the proton area. Three independent groups of tables, separated by a concrete shielding (see Figure 1), will be installed in the facility. A maximum of 3 tables per group (e.g. 9 in the whole facility) can be installed and operated. This allows the irradiation of several materials at the same time with a "clean" proton beam and minimum background induced by scattered secondary particles. Moreover, the implemented shielding configuration minimizes the dose to the personnel during the access to the different groups of tables inside the area.

On each table, the maximum volume available for irradiation is of $200\times200\times500mm^3$ while the maximum samples weight is 50Kg. The tables can automatically move (e.g. "scan") the samples during irradiation in order to provide a uniform spot over the $200\times200mm^2$ surface (or a smaller portion of it, depending on the users request). On these tables, the test of equipment "in operation" (e.g. powered and connected to a DAQ system) is possible as well as irradiation of detector components at low temperature, down to -15ºC. Two separated cooling systems, located in the outside technical area, provide chilled water and compress air for the Vortex system to specially designed thermalized irradiation boxes (see Figure 6).

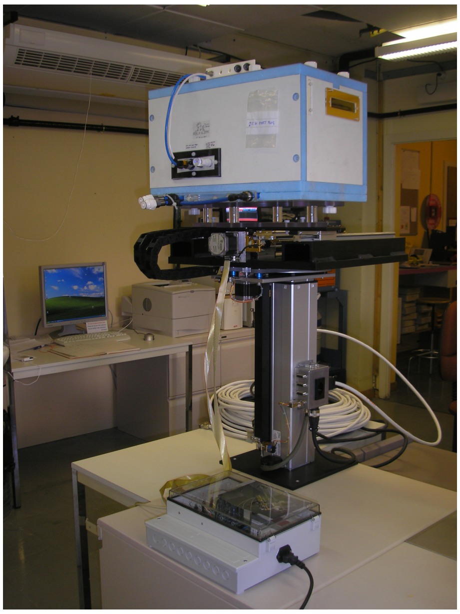

Figure 6 — Prototype of a table for proton irradiation. In this picture, one thermalized irradiation box is also installed on the table.

The shuttle is a remote-controlled conveyor travelling on a rail system that allows the positioning of "small" objects (typically silicon detector test-samples) in the beam without the need for human access into the area. This system guarantees a precise X-Y alignment of ±0.1mm with respect to the beam axis and it is manly designed for the irradiation of passive samples at RT. The shuttle for the new proton irradiation facility is cloned from the previous IRRAD1 and IRRAD2 shuttles already installed and operational on the T7 and T8 beam lines of the East Area since 1998 [9]. Figure 7 shows the detail of the shuttle with its samples holder (left-hand side), together with its loading station located next to the counting room outside the irradiation area (right-hand-side).

On the shuttle, the maximum volume available for irradiation is of 50×50×200mm^3 for a maximum weight of about 1Kg. The shuttle travels across the shielding blocks for a length of about 10m inside a conduit of 400×400mm^2. To minimize the direct radiation steaming, the path of the conduit follows a chicane located in between the first and the second group of irradiation tables (see Figure 1). The standard size of the beam spot on this system is of ~5-7mm RMS but it can vary according to the different beam focusing options (see par. 2.1). In particular, focusing on the shuttle system, the spot size could be reduced further down during high-intensity irradiation periods.

In addition, the proton facility will be also equipped with a cryostat fed with liquid Helium to allow special irradiation runs with samples exposed at cryogenic temperature down to 1.8K (see Figure 1). The cryostat will be mounted downstream of the proton area on a dedicated irradiation table (same as described above) which will allow moving it remotely into the beam or close to it. The liquid Helium will be supplied to the cryostat by manual refilling via a dedicated (permanent) transfer line connected to a Dewar located outside the radiation area. This cryogenic system will be operated by the TE-CRG group upon users request [10].

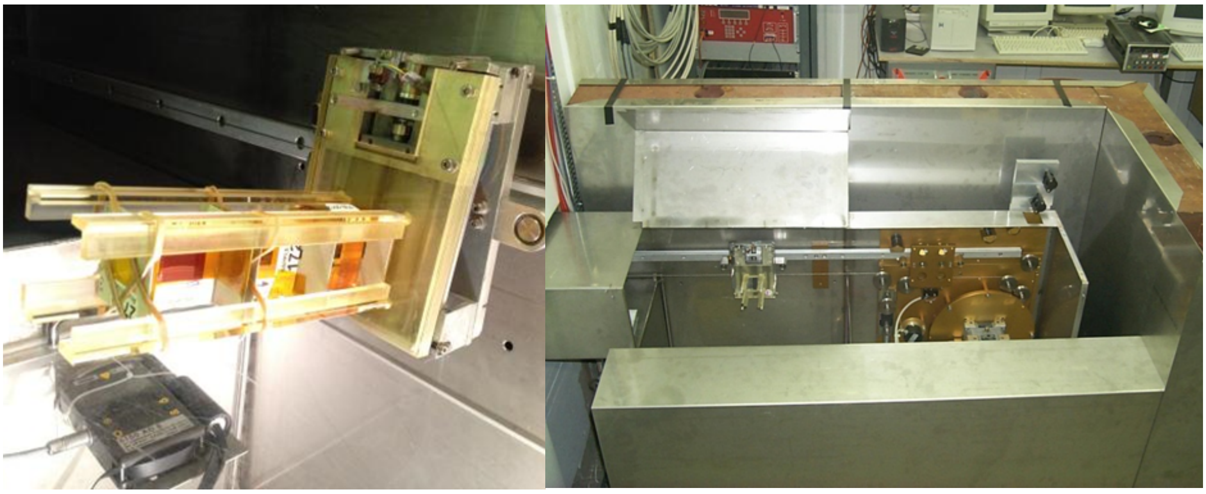

Figure 7 — Remote-controlled shuttle for proton irradiation (left-hand side). On the right-hand side, the loading station and the shuttle motorization system are visible.

3.7 Mixed field target, mobile shielding, conveyors

The proton beam (having traversed the proton irradiation facility) will impinge on the mixed field target, which is a 50 cm long and 8 cm diameter cylinder. It produces a radiation field that can be modulated by mobile shielding plates. Conveyor systems allow bringing the samples into irradiation position without exposing the personnel. An overall documentation of these systems, including their controls, is available in [11].

Three target heads are available, two made of Aluminium and one of Copper. One of the two Aluminium targets contains holes such that only about a quarter of the beam interacts and therefore the resulting radiation field is reduced by a factor of 4. The massive Aluminium target reduces the intensity by a factor 2.5 compared to the Copper one and the one with holes by a factor of 10. The positioning is precise to ±1 mm and the angle to ±0.2 degrees. The whole target structure will be mounted on a movable table, allowing the target to be moved into or out of the beam. In the latter case the target is stored behind two movable marble doors. A detailed description of the target system can be found in [12].Please note that the target motorization requires compressed air.

Two conveyers allow moving samples into or out of the test position. The test position for small samples will be used for in-beam and high-dose measurements. The samples will be mounted in a standardized test box of maximum size 300x300x200 mm^3 and maximum weight 10 kg. The positioning precision is the same as for the target. The conveyor will bring the test box into its location and then returns to its start location. In addition the system allows automatic and manual positioning of an embedded camera for visual observation inside the target chamber. This allows not only remote inspection in case of problems inside the chamber (e.g. blocked target or mobile shielding), but also monitoring of a second conveyor for larger objects (se below). The proposed Montrac system is documented in [13]. It requires compressed air.

For larger and/or heavier objects a second conveyer will be installed, which follows the path shown in Figure 8. Possible tests could use e.g. standardized 19" racks with a reduced height, allowing a common interface with cables coming from the top. The following parameters for the samples must be taken into account:

- maximum rack dimensions 1000x1000 mm,
- maximum weight 1000 kg,
- positioning to 1 cm.

In addition there is the possibility to install full systems representative of those installed inside CERN accelerators, such as UPS and power converters. See [14] for details on the conveyor systems.

A 3D motion cable holder chain will be fixed to a rail on top of the room, thus avoiding cables on the floor. Only the cables effectively used for the foreseen test will be present in the zone. Each test will use its own cable holder chain, equipped specifically for each test. Used cables will be stored in the buffer areas for future test campaigns.

Normally equipment is put in place with the conveyor, but in exceptional cases the possibility of manual installation will remain, after agreement with the RP group.

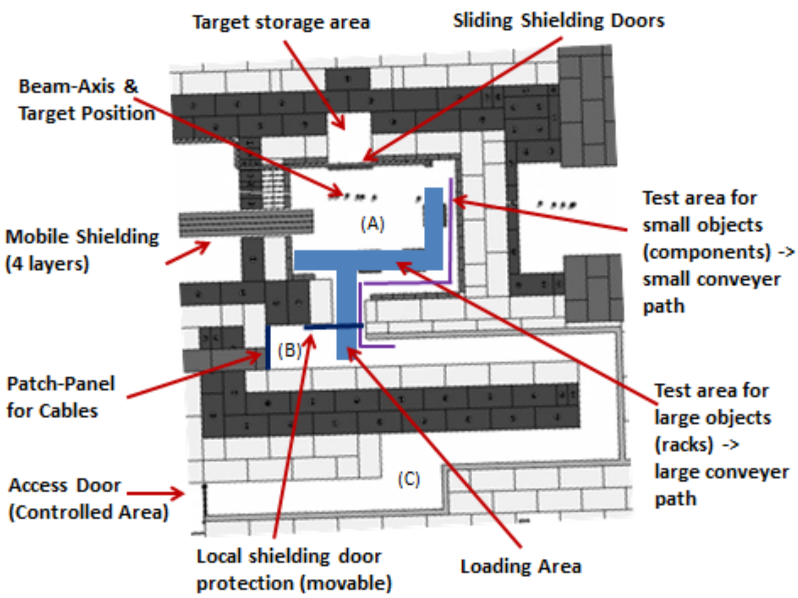

Figure 8 — The path for the conveyor system

The mobile shielding system contains 4 layers, each 400 mm thick, that can be put individually into their shielding position or retracted. Two layers are made out of cast iron and two out of concrete. The system avoids rails or other obstructions in the test area that could hamper the movements of the conveyer systems. A view of the mobile shielding system is shown in Figure 9 and a more detailed documentation is available in [15]. The shielding plates are motorized with remote control.

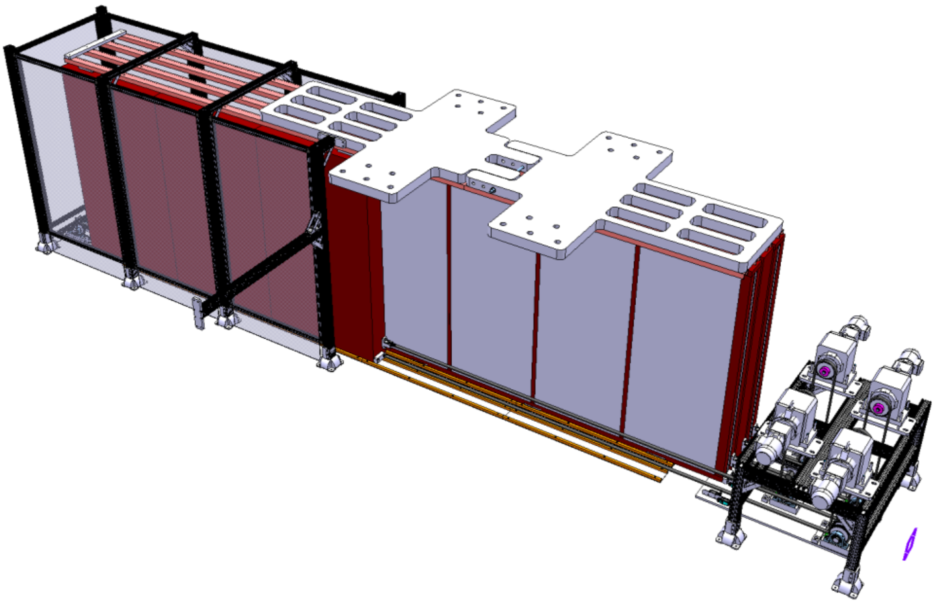

Figure 9 — The layout of the mobile shielding system

3.8 Ventilation

The ventilation system has been defined in close collaboration with the radiation protection experts and with the EN/CV group. In view of the dose rates expected and in the absence of contamination there is no strict requirement on under-pressure. The requirement is to minimize leakage of activated air from the inside into the outside world.

This is basically achieved by making the ventilated zones moderately air tight, i.e. a leak rate of the order of 1 volume per hour or less. This will be achieved by cladding the inside of the volumes with Macrolon sheet or by sealing the gap between the concrete blocks with a special mould-resistant Silicon sealant for stone or marble (e.g. Mapesil LM). Bigger holes will be plastered. The total volume of the ventilated areas is 300 m^3. During operation the air will be re-circulated and filtered with F9-type bag-in-bag filters at a flow of at least 300 m^3/hour. Before access the air will be flushed at 5000 m^3/hr. during about half an hour to ensure that the entire volume has been replaced at least 3 times. A system of dampers allows modulating and equilibrating the air flow between the proton and mixed field volumes.

Details of the ventilation are described in the functional specification [16] and in the CV User Requirements document [17].

3.9 Cooling infrastructure

For the mixed field facility a cooling circuit for cooling of equipment to be irradiated (such as rectifiers and power converters) will be installed. This circuit will in principle be separate from other circuits, but until LS2 remain connected in series with the general circuit (only on the rare occasions when it is effectively used). On these occasions retaining vessels will be installed below the cooled equipment, to capture the water in case of leaks.

It is foreseen for LS2 to separate the cooling circuits for the magnets in the primary and secondary zones. On that occasion the irradiation facility circuit will become part of the primary zone circuit and thus be separated from the circuit for the secondary beam lines.

3.10 Electrical infrastructure

The old electrical infrastructure belonging to DIRAC and IRRAD1 & 2 was completely removed from the zones by EN-MEF. All cables have been removed from the equipment up to its rack. The beam stopper and access patch panels have also been dismantled.

New electrical infrastructure, managed by EN-EL, is foreseen for the power supply and the lightening of the mixed field and proton irradiation facilities. The new control rooms will come already pre-equipped with their electrical components and only remain to be connected to the power supply of the building.

The PAD/MAD access doors, to be installed during LS1, will be also connected to the building power distribution. The Beam Imminent Warning (BIW) and the Beam Stoppers control will have their racks in the APRON room, recently refurbished.

3.11 Cabling and services

During the dismantling of the South Side of the Hall, we take the opportunity to remove completely all obsolete and/or deteriorated cables and cable trays. In parallel we will dismantle some obsolete Cooling and Ventilation installations (manifolds, water pipes, ventilation ducts…).

A dedicate cabling campaign for the new users facilities has been defined with EN-MEF (signals cables linking control rooms and irradiations facilities) and EN-EL. Other services such as Cooling and Ventilation will be involved for supplying the new irradiations zones with compressed air and a water cooling connection.

3.12 Cryogenics

It has been proposed to test certain equipment at cryogenic temperatures, initially BE-BI Beam Loss Monitors for LHC which could be mounted in the cold mass of the LHC dipoles. The approach will be the same as the for the CryoBLM tests carried out during 2012 in the old T7 irradiation area and the same safety approval procedures will be followed [18].

As already described in the previous paragraphs, a cryostat will be installed inside the proton irradiation area. The liquid Helium (or optionally Nitrogen) will come from a dewar to be installed on the North side outside the proton irradiation area. A 12 m long cryogenic transfer will be installed, following a chicane to avoid radiation leaks, and the passage through the shielding will be made airtight.

The cryostat will be higher than the one used in 2012, such as to increase the autonomy of the system and increase the periods between refills. The length of the transfer line will be 12 meters.

3.13 Control rooms

Three new control rooms will be installed, one on the ground floor and two on the first floor. The ground floor one has a surface of 45 m^2. The first floor ones are mounted on a metallic structure and have surfaces of 55 and 20 m^2 and are separated by a platform of 16.4 m^2. The access to the first floor is via metallic stairs. The 55 m^2 room has a false floor. All rooms respect the relevant CERN and Swiss safety standards.

A metallic platform will be installed above the first floor control rooms to house the ventilation units and they can be accessed via the roof of the irradiation areas. All platforms will be surrounded by safety rails.

The control rooms are of workshop cabinet style and will arrive equipped with air-conditioning, heating and electrical infrastructure. The details are documented in [19].

3.14 Access control

Access control will be implemented for the experimental hall itself. Like for all primary zones in the PS complex the old PS-type access doors will be upgraded to PAD/MAD doors with biometry, in the framework of the PS-PSS project [3], but in close coordination with the present work in the East Area.

3.14.1 Access to the building

The access to the building will be controlled via dosimeter readers with access authorization (like in EHN1). A total of 7 personnel access doors and 3 material access doors will be equipped. Video surveillance and interphone will be installed on door 014941 and cameras on three other doors. See Figure 10 for details.

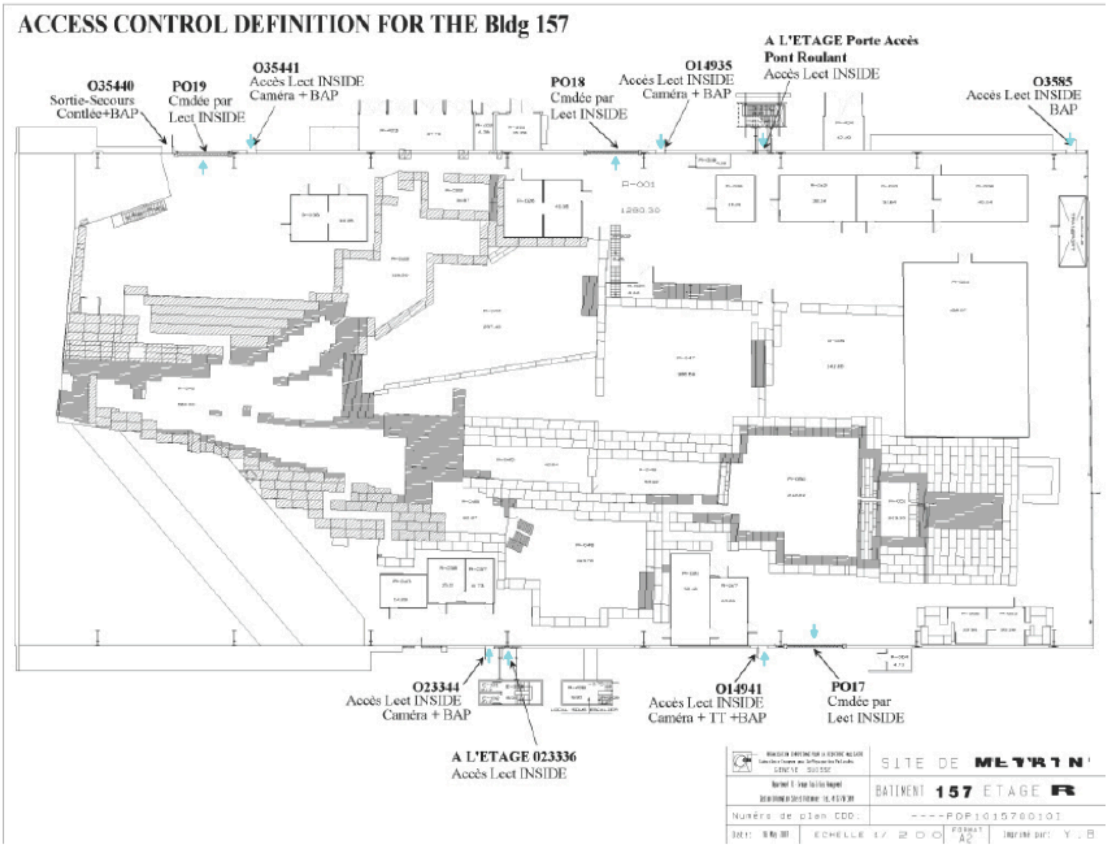

Figure 10 — The access control to the building

3.14.2 Access to the beam areas

The access to the two irradiation facilities will be via a common PAD/MAD door. From there access to the proton and mixed field parts is via separate sector doors. There is an emergency exit from the mixed field facility next to the cold buffer zone and one from exit from the proton facility into the T8B zone. The sectorisation is indicated in Figure 11. The access elements and interlocks are described in [20]. The implementation is done and funded in the framework of the PS-PSS project [3].

The access to the secondary beam zones (T9, T10, T11) has been renovated in 2007 and therefore no special action will be taken at this stage.

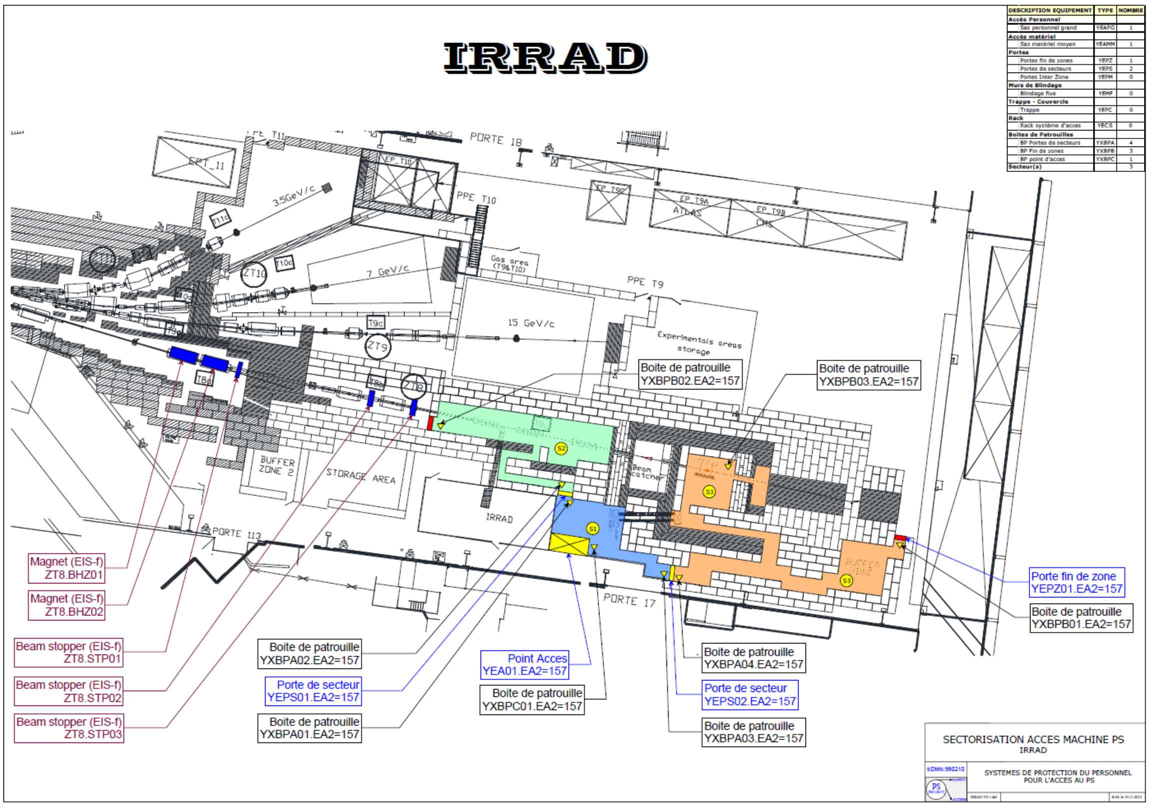

Figure 11 — Access sectorisation for the new irradiation facilities

3.14.3 Escape routes

The big gate #17 on the South side of the hall has been blocked by shielding walls. As a consequence a new escape door has to be provided. We may either use the existing door to access B157/R-408 (less convenient) or to add a new door in the main South wall of building 157.

3.15 Alarms

In both irradiation areas Oxygen Deficiency alarms and smoke and fire detection will be implemented. Beam Imminent Warning signals (visual and acoustic) will be provided via the PS PSS access system upgrade project. Radiation alarms come in the framework of the RAMSES project (see section 4.6). In case of fire or smoke detection, an alarm will be raised in the CCC and power will be cut. However, it is left up to the operators and the Fire Brigade to manage the ventilation system status. Note that fire detection is not a formal requirement by HSE, but a recommendation, in view of the small fire loads.

In the control rooms fire detection and smoke detection will be installed.

Local emergency stops will allow cutting the power in case of electrical danger.

4. Other consolidation work during LS1

4.1 Replacement of splitter magnet by a MCB

Following a problem with the jaw positions of the MSH01 splitter magnet in the F61 line at the start-up in 2012, and knowing that this magnet no longer works as a splitter since 2007 (F61S.BHZ01 replacement by a MCB magnet), it has been decided to also replace the SMH01 magnet by a MCB-type dipole.

4.2 PAD/MAD installation for primary zone

Also in the primary zone, door 151 will be replaced by a PAD/MAD-type access door and door 152 will be replaced by an emergency exit. The corresponding sectorisation diagram is shown in Figure 12. The documentation can be found in [21].

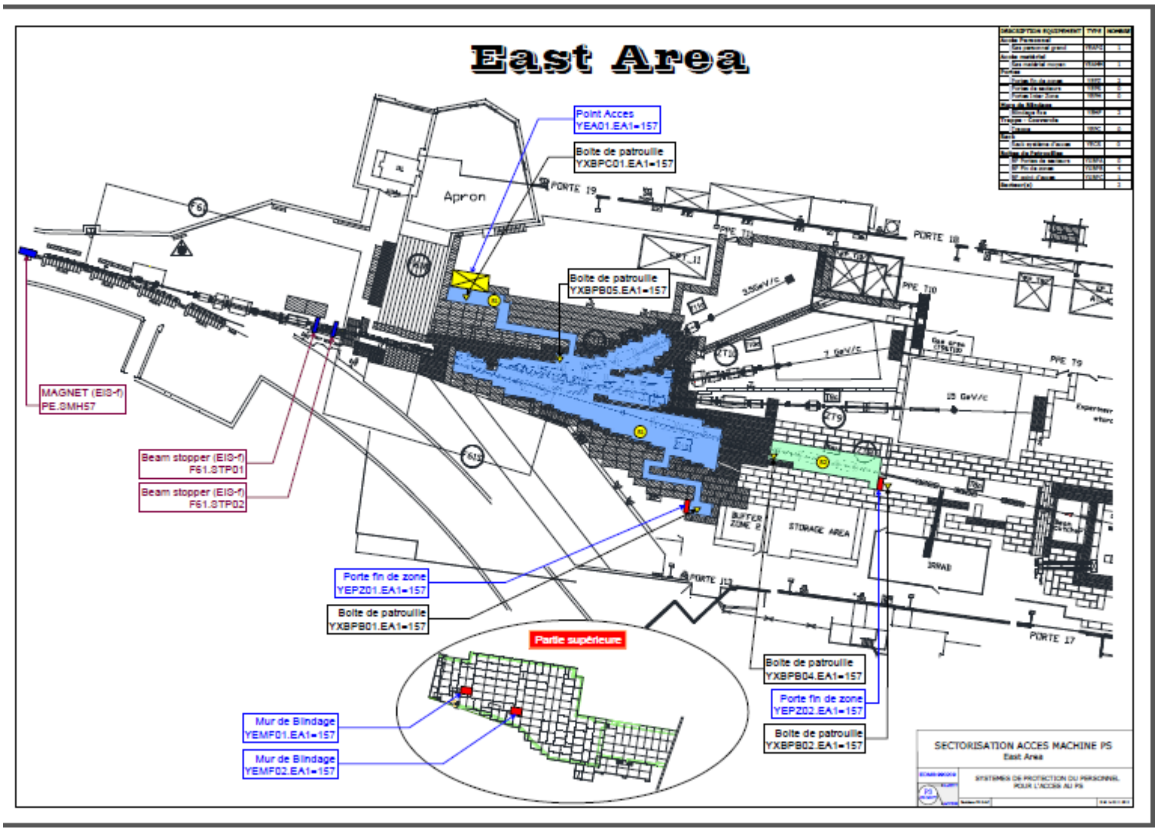

Figure 12 — Sectorisation of the primary zone

A detailed view of the PAD/MAD layout is shown in Figure 13.

4.3 Primary zone roof modification

A design study will be made to check if the primary zone roof block layout can be made without staggering from the second concrete layer onward. This would allow to reduce significantly the intervention time and work load in case of interventions on equipment inside the primary zone. Seismic stability has to be taken into account.

As the roof has to be opened anyway for the beam stopper consolidation and for magnet repairs, this will be the occasion to implement the new layout.

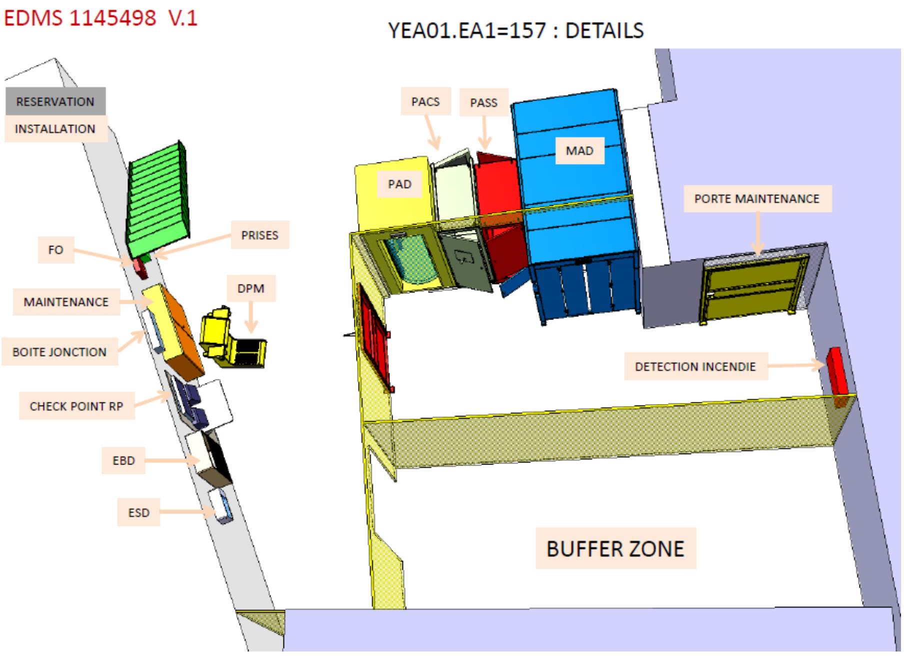

Figure 13 — Overview of the PAD/MAD integration

4.4 Marguerite target upgrade

The marguerite will be replaced by new units with a linear movement into 4 discrete positions and based on the technology used in Linac4. A second axle will allow the positioning of up to 4 screens that can this be moved into the beam and left there during operation, independent of the target head. The specification is available in [22].

4.5 Beam stopper consolidation

Advantage is taken of the long cool-down time in LS1 to consolidate the beam stoppers. It is proposed to consolidate/replace the 7 beam stoppers (5 in the primary zone, 2 in the T8 beam line) with standardised ones, where the active part is a 300 mm diameter Copper block. The length of the block and the container will be adapted to the varying requirements in terms of beam intensity and zone layout.

4.6 Ramses upgrade

The obsolete ARCON system, connecting the radiation monitors to the beam interlock system, will be upgraded to the modern standard RAMSES system. The locations of the different monitors are indicated in Figure 14 for the South half or the hall and in Figure 15 for the Northern part.

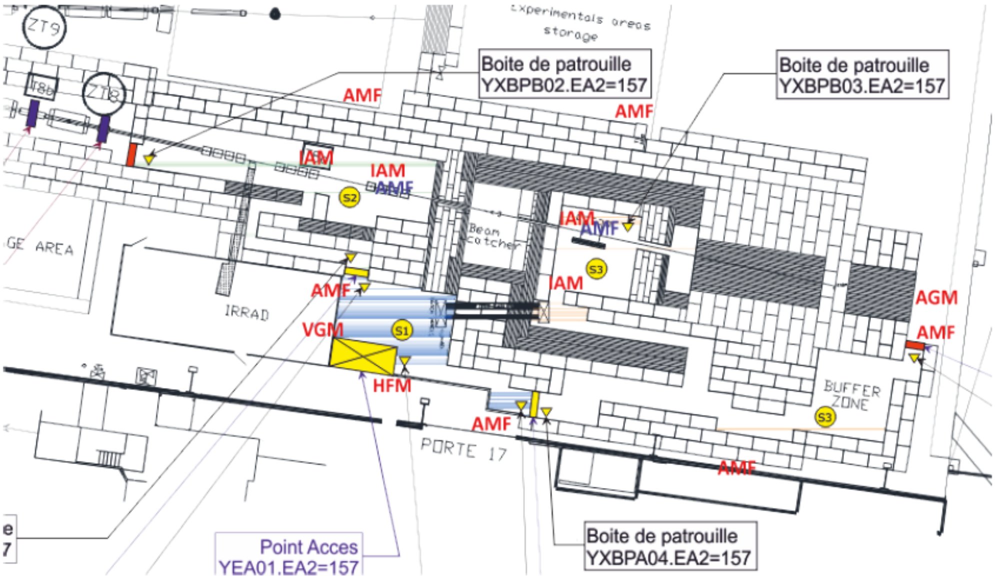

Figure 14 — Locations of the radiation monitors in the Irradiation Facilities

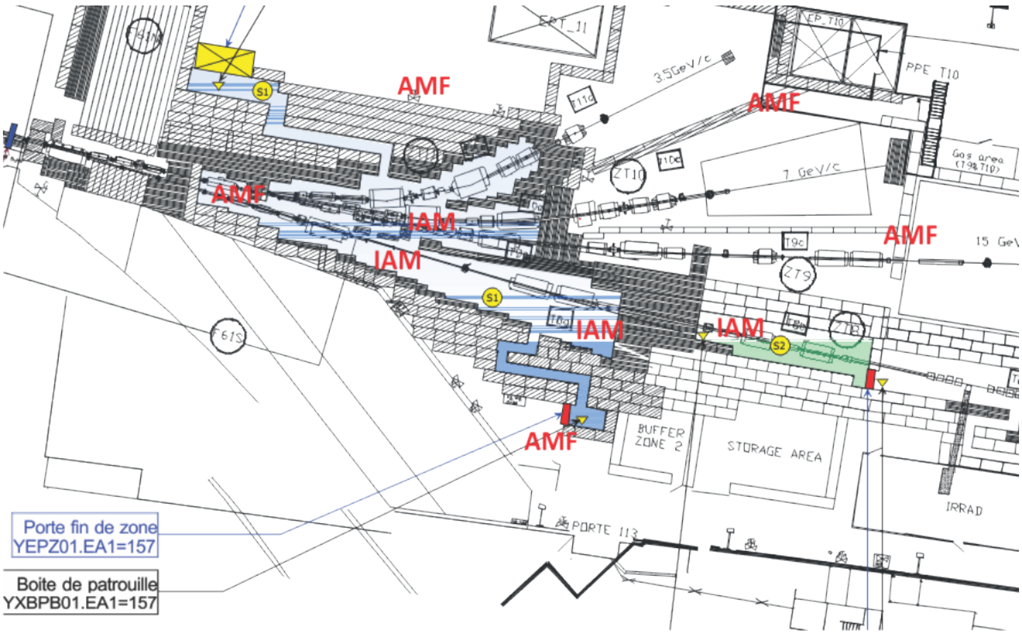

Figure 15 — Locations of the radiation monitors in the North branch

The system also includes monitoring of the air extracted by the ventilation system.

4.7 Magnet repairs

Several magnets in the East Area complex require repair or replacement. In the PS ring zone the MNP24A type magnet in position F61.DHZ1 will be replaced by a spare one and the M105 type magnet in location F61N.DHZ1 will be renovated.

In the T9 beam the Q200 magnets QDE6 and QFO7 the cooling water hoses are damaged. These tubes or possibly even the magnets must be replaced. These are located at the end of the secondary beam and are easily accessible. On QFL-type quadrupole ZT9.QFO4 a metal hose was provisionally replaced by a flexible one and a definitive repair will be done during LS1. Some bad connections on ZT9.BVT1 and ZT9.QFO4 lead to local overheating and must be repaired.

In the primary zone the two first quadrupoles in the T10 beam, QDE1 and QFO2, are both of type Q800 and severely degraded but stable. They can no longer operate at the nominal current for 7 GeV/c (700 Amps) due to the increased (early 2000's) cooling water inlet temperature and limit the maximum beam momentum of the T10 beam to 6 GeV/c. However, as no spare are available, the only economical solution would be their replacements by QDS type quadrupoles. This would recover the 7 GeV/c beam momentum, but reduce the beam acceptance and flux by about a factor of 2 due to the smaller aperture. It was thus decided to continue with the Q800 magnets for the moment.

4.8 Cesar beam controls

Both the user community and the support teams have strong overlap with the North Area teams. As the Cesar control system for the North Area lines can be adapted to the East Area and provides useful additional functionality (e.g. beam files, scans), it was decided to implement Cesar to the East Area at least for those aspects where the hardware is compatible. It should be noted that the existing collimators are for the moment not equipped with hardware for remote control and will therefore not be included in Cesar before LS2.

4.9 Studies

In the proposal for the second phase of the East Area upgrade program the T11 beam has been suppressed and the CLOUD experiment moved to a downstream zone behind the test area in the new T9 beam. On request of CLOUD it will be studied whether it is possible to maintain some version of a dedicated beam for CLOUD and what would be the impact on operation and maintainability of the new East Area.

All magnets in the secondary beams and many in the primary beams are operated in DC mode. As the duty cycle of the East Area is very low, pulsing of those magnets would lead to a considerable reduction of power consumption and cost. The savings could offset rather quickly [23] the cost of new laminated magnets and the extra cost for rectifiers. Moreover, the reduced power consumption would lead to reduced magnet heating and thus reduce the required cooling and electrical infrastructure. A study will be made on how to streamline the magnet modifications (minimize the different types) and adjust the beam layout and optics accordingly. Following the design modifications the expected savings will be elaborated.

5. Safety aspects

5.1 Safety file

A safety file is under construction with the help of EN/HDO and all the technical teams involved. The present version can be found at [24].

5.2 Other safety aspects

Safety issues are discussed along with all technical issues in the regular meetings. The minutes and presentations can be accessed from the indico pages at address http://indico.cern.ch/categoryDisplay.py?categId=4451.

6. Costs

The estimated costs are listed, per year, in the table below.

Description	**2012**	**2013**	**2014**	**Total**
Crane renovation	155	565	-	720
Civil engineering				-
Ramses and RP monitoring		100	350	450
Access system		25	80	105
Cooling and Ventilation		25	225	250
Transport and heavy handling		170	60	230
Equipment upgrade and controls		240	1000	1240
Splitter replacement			30	-
Studies		100	10	110
General infrastructure and misc		244	489	763
Total	**155**	**1469**	**2244**	**3868**

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