

SAFETY MANUAL FOR SPECIAL USE OF A RADIOACTIVE SOURCE : **BLM TEST/CALIBRATION FOR LHC COMMISSIONING – 4040-41RP – ^{137}Cs**

1. DESCRIPTION OF THE INSTALLATION

Two sources will be used for the test and calibration of the LHC Beam Loss Monitors (ionisation chambers) during the LHC commissioning. For next years, after the LHC starting, the present safety manual will have to be revised in order to take into account new safety rules according to the radiation levels into the LHC. The sources will be moved from one monitor to other at all sectors of the LHC and the two dump lines.



Figure 1 Demonstration of irradiation procedure. The source clamp is on the left side and the operating person is on the right side, keeping the distance in between maximal.

The sources are located in two close able trolleys which carries one source and its lead housing. During the measurements one source is put directly onto the surface of the ionisation chamber. It is guided from the housing by a flexible tube clamped on to ionisation chamber by a gripper. The source is moved through the flexible tube by a steel cable pushed or pulled from the other side of the housing by an operator. During this procedure the person is staying at least five meters away from the source housing and detector gripper.

2. PROCEDURE FOR SOURCE INSTALLATION

The irradiator cover shall be opened. On the right site of the source housing is the transition between a steel tube coming out of the source housing and a flexible cable (black). The fixation is ensured by a screwed clamp. The clamp has to be disengaged by unscrewing 4 screws. The fitting has to be pulled out to the right site; the inner steel cable will be visible with the threaded adapter at the end of the cable. The source has to be screwed in the source adapter. The threaded adapter is gripped with a specially fitting gripper. The source will be taken with a rod holder. The rod with the source at one end is aligned to the threaded adapter and screwed in. The gripper is also used to fix the source by deforming the threaded adapter at the predefined locations. The source is now brought with the gripper to the steel tube of the source housing and pushed in by pushing the cable. The flexible cable (black) is engaged by tightening the 4 screws of the clamp.

3. PROCEDURE FOR SOURCE REMOVAL

The irradiator cover shall be opened. On the right site of the source housing is the transition between a steel tube coming out of the source housing and a flexible cable (black). The fixation is ensured by a screwed clamp. The clamp has to be disengaged by unscrewing 4 screws. The fitting has to be pulled out to the right site; the inner steel cable will be visible with the threaded adapter and the source at the end of the cable. The source will be taken with the gripper, the cable is cut and the threaded adapter is unscrewed with the special fitting gripper.

4. SAFETY MEANS DESCRIPTION

4.1. Equipments

The source is located in a close able trolley which carries the source and its lead housing. The lead housing, so-called "garage" (lead thickness ≥ 8 cm) is designed to keep the source when not used and when moving of the trolley. The dose rate at surface of the garage is ≤ 0.2 $\mu\text{Sv/h}$ at all point except close to the extraction tube, but doesn't exceed 5 $\mu\text{Sv/h}$.

Into the floor of the trolley, there is a lead castle. It is kept to be able to store the source if it would be removed from the wire.

To prevent the source from being moved when not used, i.e. between irradiation steps and after the end of the work, a stop is installed on the garage. When the stop is down, the source cannot be moved, when the stop is up, the source is released (set free) and the flashing panel which indicates an "irradiation in progress" is flashing.

The source is guided from the housing by a flexible tube clamped on to the ionisation chamber by a gripper. The source is moved through the flexible tube by a steel cable pushed or pulled from the other side of the housing by a person. During this procedure the operators are staying at least five meters away from the source housing and detector gripper. Therefore the dose rate at the work place is always ≤ 1.5 $\mu\text{Sv/h}$.

During the source movement the dose rate is checked automatically with a Geiger-Muller probe connected to a Min-Alarm box. The Min-Alarm gives a sound signal continuously whenever the source is out of the garage. The alarm level is set by SC/RP before the test campaign, when the source is lent in order to ensure that the above-described functioning will be observed. When the source is retrieved to its garage the Min-Alarm stops sounding as soon as the dose rate has reached the pre-defined level, i.e. ensuring that the source is back into the garage.

In addition, when the stop on the garage is pull down, the operator has the confirmation that the source is well-placed inside the garage.

To ensure the autonomy, the safety equipments using electricity on the trolley works on a battery with more than 48 hours autonomy ($I_{max} = 200 \text{ mA}$, $C_{batt.} = 10 \text{ Ah}$). The trolley is equipped with a switch in order to cut off the alimentation when it is closed and not used.

4.2. During calibration/tests

During the use of the source, the area will be classified as “limited stay area” with warning signs at least 10m before and after the trolley. The operators working with the source into the area wear their operational dosimeters in addition to their individual dosimeters.

They will register their doses into a special book for dose records that will be kept into the trolley. In case of an individual daily dose higher than $10 \mu\text{Sv}$, the operators will have to contact SC/RP in order to check the irradiator.

In order to work with the source, there must be 2 operators.

An operational procedure (available in Appendix 1) details each step of the work with a BLM irradiator, it is displayed into the trolley available for all operators.

List of people allowed to operate a BLM irradiator:

- | | | |
|-----------------------|----------------------|-----------------------|
| - Ewald EFFINGER | - Virginia PRIETO | - Bernd DEHNING |
| - Christophe VUITTON | - Gianfranco FERIOLI | - Victor KHLOPKOV |
| - Viatcheslav GRISHIN | - Raymond TISSIER | - Yury MISHAGIN |
| - Christos ZAMANTZAS | - Ion SAVU | - Alexander PUSHKAREV |
| - Jonathan EMERY | - Romain RUFFIEUX | - Yury ALEXANDROV |

In order to avoid co-activity, the source responsible will fill in every week one ADI per irradiator ([Notice of Intervention](#)) in EDH. The ADI documents will be to be sent for signature, in addition to the normal process, to Radioactive Source Service (i.e.: G. Dumont + Y. Donjoux in case of absence). Indeed, these ADI will be used to update the Radioactive Source Database (GESO) which is the database used by Fire Brigade to check the presence of sources in case of accident/incident. Therefore, the ADI should detail the storage place (i.e. one of the places listed above) and the places for use (e.g. sector 6-7).

4.3. Out of calibration/tests

To prevent the source from being moved when not used, a stop is installed on the garage. When the stop is down, the source cannot be moved.

The source is located in a closeable trolley which is pad-locked when not used. The dose rate at 40cm from the surface of the trolley is $\leq 0.5 \mu\text{Sv/h}$. Therefore, the trolley can be stored in a non-designated area.

During the test/calibration period, the irradiators are kept in the LHC tunnel to avoid too much handling and transport. However, the storage locations are defined in advance for Fire Brigade information; they are given below:

- LHC/Point1: US15-level 0 (under stair case, near elevator)
- LHC/Point2: US25-level 0 (under stair case, near elevator)
- LHC/Point3: TZ33 near to the door to UJ33
- LHC/Point4: US45-level 0 (under stair case, near elevator)
- LHC/Point5: UJ56-level 0 (near the stair case, near elevator)
- LHC/Point6: US65-level 0 (under stair case, near elevator)
- LHC/Point7: UJ76-level 0 (under stair case)
- LHC/Point8: US85-level 0 (under stair case, near elevator)

Out of this period, when the irradiator should not be used within a week or more, it will be sent back to SC/RP storage, building 225/R-401, until the next checking campaign.

5. PERIODIC CHECKS OF THE SOURCE INTEGRITY

As the test campaigns should last less than 4 months, the sources won't be lent more than one year. Therefore the periodic check of the sources will be performed when lending and returning the sources.

APPENDIX 1 OPERATIONAL PROCEDURE:
FOR USE OF THE BLM IRRADIATORS IN THE LHC TUNNEL
SOURCES 4040RP AND 4041RP – ¹³⁷Cs

The radiation sources + their irradiation apparatus (so-called irradiators) are each one operated by two persons. Each person (Operator 1: OP1, Operator 2: OP2) has its role during the procedure. Each operator has to be under dosimetry follow up (at least as B worker) and needs to carry, in addition to his individual dosimeter (DIS), an operational dosimeter (DMC).

- 1) The irradiator is taken from its parking position and brought to the location where the BLM test/calibration should be done.
If the irradiator is connected to the power outlet it has to be disconnected and the cable has to be stored on the outside holder.
- 2) OP2 shall place at the area where the irradiator will be used a "controlled area - limited stay" sign and a chain 10 m in front and 10 m behind the irradiator.
- 3) OP1 shall open the cover of the irradiator and the "Minalarm" (radiation sensor) is switched on (green light and small LED on at instrument).
 - In case of starting the irradiation campaign the OP1 and OP2 have to register their initial dosimeter dose value in the logbook located inside the irradiator.
 - OP1 shall switch on the dose rate meter (AD6), located inside the irradiator. The dose at a distance of 40 cm from the trolley should be $\leq 2.5 \mu\text{Sv/h}$.
- 4) OP1 shall take the push/pull cable and moves 5 m away from the irradiator and the next measurement locations.
- 5) OP2 shall take the irradiator gripper and clamp it on the BLM.
- 6) OP2 shall move to the irradiator and unlocks the "source stopper" the "flash light sign" will start flashing.
- 7) OP2 moves near to OP1 at least 5 m away from the irradiator and the next measurement locations.
- 8) OP1 shall move the source out of the housing onto the ionisation chamber. The alarm of the Minalarm should switch on (sound alarm) and will indicate that source has left the housing.
- 9) During the measurements nobody is allowed to approach the irradiator housing or the irradiator by more than 5 m.
- 10) To move the source from one detector to the next or finish the measurements the source is pulled back into its housing by OP1. The "Minalarm radiation sensor" should switch off (if not please see section below: Problems with the irradiator).
- 11) OP2 shall close the "source stopper" the "flash light sign" will stop flashing.

- 12) Next three cases are possible: irradiator needs to be moved or not and measurements are finished.
- Irradiator not moved:
 - OP2 shall take the source gripper and move it from one BLM to the next.
 - The procedure starting at item 6) is now repeated
 - Irradiator to be moved:
 - OP2 shall put the source gripper into the irradiator
 - OP1 shall put the “push/pull cable” into the irradiator and closes it.
 - OP2 shall take the signs and the chain and puts onto the irradiator.
 - The procedure starting at item 1) is now repeated
 - Irradiator to be moved back to its storage position:
 - OP2 shall put the source gripper into the irradiator
 - OP1 shall put the “push/pull cable” into the irradiator
 - OP1 and OP2 have to register their final dosimeter dose value in the logbook located inside the irradiator. If an operator takes more than 10 μSv in one day, SC/RP will have to be informed immediately.
 - OP2 shall place the signs and chains back into the trolley
 - OP1 shall close the irradiator and lock it with a padlock.
 - Then the irradiator is moved to one of its parking position listed below (pictures shown below in Figure 2):
 - LHC/Point1: US15-level 0 (under stair case, near elevator)
 - LHC/Point2: US25-level 0 (under stair case, near elevator)
 - LHC/Point3: TZ33 near to the door to UJ33
 - LHC/Point4: US45-level 0 (under stair case, near elevator)
 - LHC/Point5: UJ56-level 0 (near the stair case, near elevator)
 - LHC/Point6: US65-level 0 (under stair case, near elevator)
 - LHC/Point7: UJ76-level 0 (under stair case)
 - LHC/Point8: US85-level 0 (under stair case, near elevator)
 - OP1 shall put the charger plug into the outlet.
- 13) Problems with the irradiator
- The source is completely pulled back in its housing, but:
 - the “Minalarm radiation sensor” is still on: **Call the SC/RP immediately**
 - The dose rate at a distance of 40 cm from the trolley is **not** $\leq 2.5 \mu\text{Sv/h}$.
Call the SC/RP immediately
 - The “Minalarm radiation sensor” defect (after test button usage green light and LED indicators are still off): **Call the SC/RP**

IN CASE OF INCIDENT/ACCIDENT:

Ask for radiation protection assistance:

- SC/RP during working hours:
Radioactive Source Service: **73171**
Radiation Protection LHC for LHC tunnel: 75252
- Out of working hours but in case of emergency only:
On-call Radiation Protection: **74444**
- Source responsible:
Ewald EFFINGER: 164950

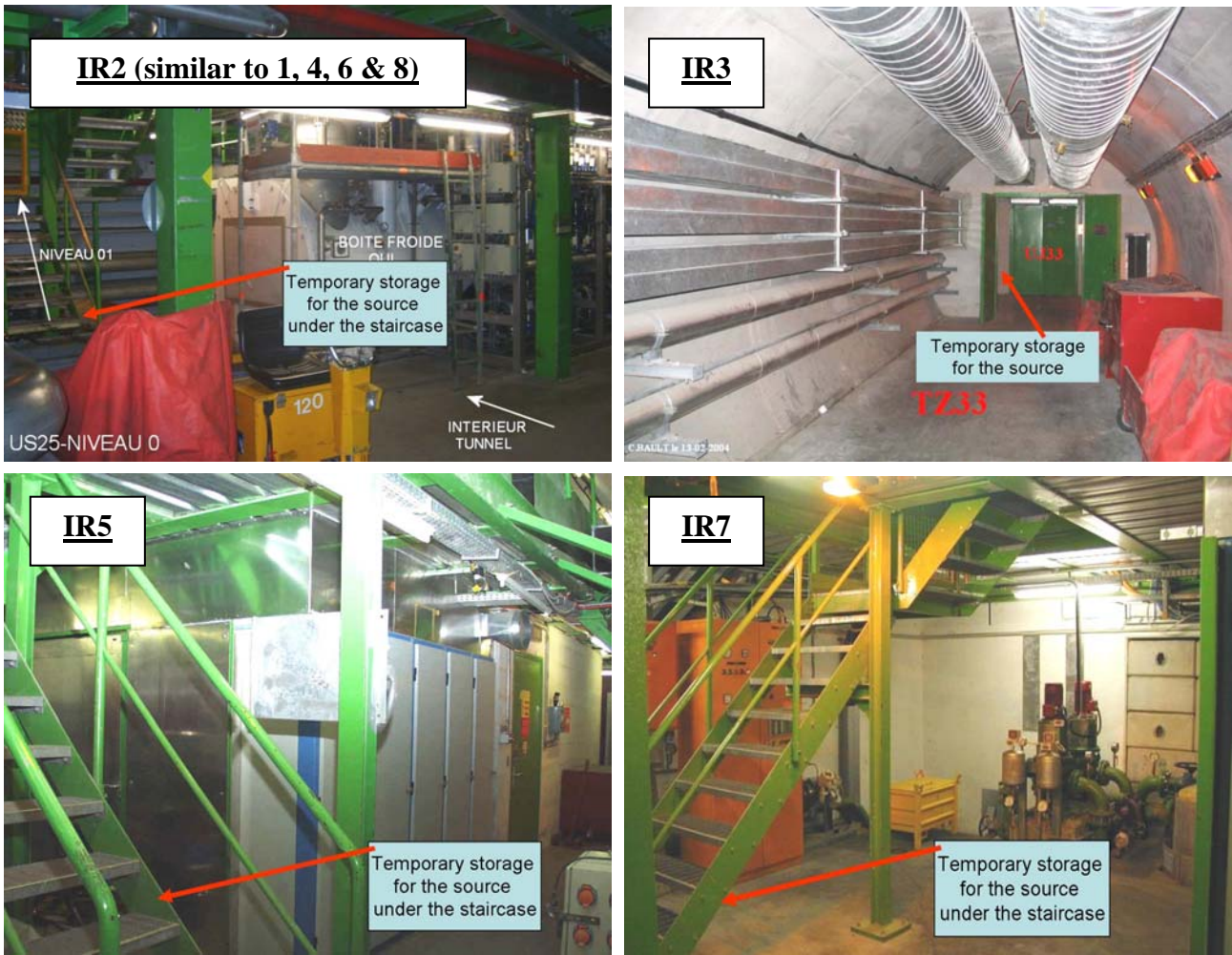


Figure 2 Pictures of the storage place in LHC tunnel

APPENDIX 2 MODE OPERATOIRE
POUR L'UTILISATION DES IRRADIATEURS BLM DU LHC
SOURCES 4040RP ET 4041RP – ¹³⁷Cs

Les sources radioactives incluses dans leurs appareils d'irradiation (nommés i-après irradiateurs) sont manœuvrés chacun par deux personnes. Chaque personne (Opérateur 1 :OP1, Opérateur 2 : OP2) a son rôle pendant la procédure.

Chaque opérateur doit être sous contrôle dosimétrique (au moins comme travailleur de catégorie B) et doit porter, en plus de son dosimètre personnel (DIS), un dosimètre opérationnelle (DMC).

- 1) L'irradiateur est déplacé de sa position de parking et transporté dans l'emplacement où le test/calibration des BLM doit être effectué. Si l'irradiateur est connecté à l'alimentation 220V, déconnecter le câble secteur et le ranger sur le support prévu à cet effet.
- 2) OP2 doit délimiter la zone où l'irradiateur sera utilisé avec des panneaux « zone contrôlée – séjour limitée » et des chaînes de balisage. La délimitation doit être positionnée 10m en amont et en aval de l'irradiateur.
- 3) OP 1 ouvre le couvercle du chariot où est logé l'irradiateur, le « Minalarm » (détecteur de radiations) sera automatiquement mis en marche (LED + indicateur vert allumés sur l'appareil).
 - Si l'irradiation des BLM débute OP 1 et OP2 doivent noter la valeur de la dose de leurs dosimètres dans le logbook situé à l'intérieur de l'irradiateur.
 - OP1 enclenchera l'appareil de mesure de débit de dose (AD6) situé à l'intérieur de l'irradiateur. Le débit de dose à 40 cm du chariot doit être inférieur à 2.5 µSv/h.
- 4) OP1 prend le câble de commande de l'irradiateur et se place à 5m en arrière de l'irradiateur et de la position de mesure.
- 5) OP2 prend la pince de l'irradiateur et la fixe sur le BLM à tester.
- 6) OP2 se déplace vers l'irradiateur et déverrouille la tige d'arrêt de la source. A ce moment « le panneau lumineux » se met à clignoter.
- 7) OP2 se déplace à côté d'OP1, les deux opérateurs doivent être situés à au moins 5m de l'irradiateur et du BLM à tester.
- 8) A l'aide du câble de commande, OP1 pousse la source à l'extérieur du garage jusqu'au BLM (en butée sur la pince). Le Minalarm doit alors émettre un signal sonore, ce qui indique que la source a quitté le garage.
- 9) Pendant la mesure personne n'est autorisé à approcher à moins de 5m de l'irradiateur ou du BLM testé.
- 10) Pour déplacer la source d'un BLM à un autre ou arrêter les tests, OP1 replace (à l'aide du câble de commande) la source dans le garage. A ce moment l'alarme du Minalarm doit s'arrêter (dans le cas contraire voir la section : Problèmes avec l'irradiateur).
- 11) OP2 bloque à nouveau la source au moyen de la tige d'arrêt, le panneau lumineux doit cesser de clignoter.
- 12) Trois cas de figures peuvent se alors présenter : l'irradiateur doit être ou ne doit pas être déplacé, ou alors les mesures sont terminées.
 - L'irradiateur n'est pas déplacé :
 - OP2 prend la pince d'irradiation et la place sur le prochain BLM.
 - La procédure est alors répétée à partir du point 6.

- L'irradiateur doit être déplacé :
 - OP2 range la pince d'irradiation dans l'irradiateur.
 - OP1 range le câble de commande dans l'irradiateur.
 - OP2 prend le panneau « zone contrôlée – séjour limitée » et les chaînes de balisage, les range également dans le chariot et ferme le couvercle.
 - La procédure est alors répétée à partir du point 1.
- L'irradiateur doit être ramené à son emplacement de parking.
 - OP2 range la pince d'irradiation dans l'irradiateur.
 - OP1 range le câble de commande dans l'irradiateur.
 - OP1 et OP2 doivent noter les doses finales de leurs dosimètres dans le logbook situé à l'intérieur de l'irradiateur. Si un opérateur a reçu une dose supérieure à $10\mu\text{Sv}$ en un jour, SC/RP doit être informé immédiatement.
 - OP2 prend le panneau « zone contrôlée – séjour limitée » ainsi que les chaînes de balisage et les range dans le chariot.
 - OP1 ferme l'irradiateur et verrouille le couvercle du charriot avec un cadenas.
 - L'irradiateur est ensuite transporté jusqu'à l'une des positions de parking suivantes (cf. photos Figure 3) :
 - LHC/Point1 :US15-niveau 0 (sous l'escalier, à côté de l'ascenseur)
 - LHC/Point2 :US25-niveau 0 (sous l'escalier, à côté de l'ascenseur)
 - LHC/Point3 :TZ33- à côté de la porte qui mène à UJ33
 - LHC/Point4 :US45-niveau 0 (sous l'escalier, à côté de l'ascenseur)
 - LHC/Point5 :UJ56-niveau 0 (sous l'escalier, à côté de l'ascenseur)
 - LHC/Point6 :US65-niveau 0 (sous l'escalier, à côté de l'ascenseur)
 - LHC/Point7 :UJ76-niveau 0 (sous l'escalier)
 - LHC/Point8 :US85-niveau 0 (sous l'escalier, à côté de l'ascenseur)
 - OP1 branche le chargeur à la prise secteur 220V.

13) En cas de problème avec l'irradiateur :

- La source a été envoyée dans son garage en plomb mais :
 - le Minalarm reste allumé en rouge et continue à émettre un signal sonore: **Appeler immédiatement le SC/RP.**
 - Le débit de dose à une distance de 40cm du chariot n'est pas inférieur à $2.5\mu\text{Sv/h}$: **Appeler immédiatement SC/RP.**
- Le Minalarm est défectueux (la lumière verte et la LED reste toujours éteinte) : **Appeler immédiatement le SC/RP.**

EN CAS D'ACCIDENT :

Demander une assistance radio protection :

- SC/RP durant les heures ouvrables :
 - Service de gestion des sources radioactives : **73171**
 - Radioprotection pour les installations LHC : 75252
- En dehors des heures de travail et seulement en cas d'urgence :
 - Piquet Radioprotection : 74444
- Responsable des sources :
 - Ewald EFFINGER:164950

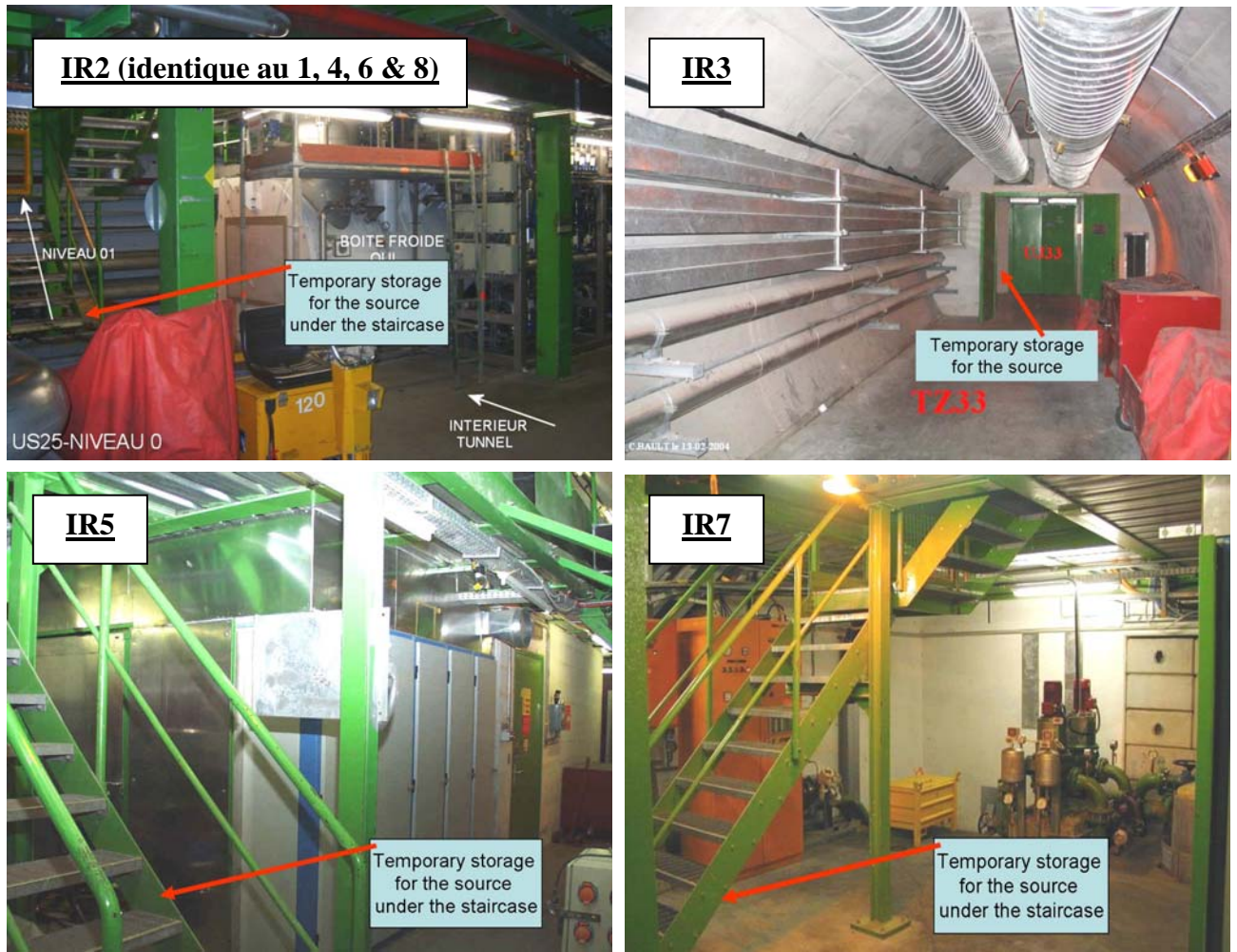


Figure 3 Photos des emplacements de stockage dans le tunnel LHC