ISOLDE intensity limit

J. Vollaire HSR/RP (06/02/2017)

Outline

- Origin of the limit and documentation
- Operational radiation protection considerations
- Environmental protection considerations
- Tentative preliminary conclusions

Sullivan (1997: design)

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EUROPEAN LABORATORY FOR PARTICLE PHYSICS

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CERN/TIS/RP/93-13

P00016480

RADIATION SAFETY AT ISOLDE

A.H. Sullivan

Abstract

This report describes the radiation safety features that have been incorporated in the design of the new ISOLDE facility that uses the 1 GeV proton beam from the PS Booster. The philosophy on which the shield design has been based as well as the details of the shields for the beam transfer tunnel and ISOLDE target area are given.

3) Radiation safety design criteria

The design of radiation safety features for the facility depends on an assessment of the position and intensity of likely beam losses as well as defining the external dose rates and radioactivity release limits that can be allowed The new ISOLDE facility was designed assuming the following criteria.

3.1 The proton beam.

The target area is specified to handle the maximum possible booster beam of 3.2 10^{13} protons at 1 GeV per 1.2 seconds (average beam current 4.3 μA and power 4.3 kW). The maximum beam will only be possible if the Booster operation is dedicated to ISOLDE which will be a very rare condition and during normal running the average beam is expected to be less than 50% of the full beam given above. For purposes of calculating radiation and radioactivity levels during normal operation of ISOLDE an average beam of 10^{13} protons per second is assumed to be incident on a one interaction length medium atomic weight target at either target position. It is further supposed that the annual integrated proton beam will not exceed 2 x 10^{20} protons per year onto the 2 target stations (4000 hours operation per year).

Today 2.8 kW average limit / 1.25x10^{13} pps / 1.4 GeV

Sullivan (1997: design)

10.2 Environmental impact.

The annual dose at the nearest point of the site border due to operation of the facility is expected to be less than 130 μSv/year of which up to 100 μSv will be from skyshine neutrons and 30 μSv of gamma radiation from the release of 21 TBq of radioactive air as indicated in Table 3. These doses are a small fraction of the natural radiation levels and are of the order of 10% of the agreed CERN "fence post" dose limit. Any release of radioactive liquids as ground-water or through the drains as well as the release of radioactive aerosols through the ventilation system are expected to be barely detectable and far below agreed limits.

The incorporation of additional concrete shields around the targets and dumps should ensure that the residual radioactivity in the earth around the target area tunnel after many years of operation will not exceed a total of 20 GBq of isotopes with half-lives greater than 60 days.

Report from 2006 (SC/RP)

Safety Commission

Internal Report
CERN-SC-2006-036-RP-IR
EDMS No. 774 367 v.1

Releases of Radioactive Air from the ISOLDE facility

Alexandre Dorsival, Thomas Otto, SC-RP; Pavol Vojtyla, SC-IE

Abstract

Users demand to increase the annual amount of protons on the two ISOLDE targets to produce radiocative beams of higher intensity. This report reassesses the dose to members of the public from release of radioactive air from ISOLDE.

observed that these monitors give numerous alarms when the proton beam current at the ISOLDE is increased beyond 1.25×10^{13} s^{-1} or 2 μA. The reason is the entrainment of packages of radioactive air in the lees of the adjacent buildings by strong wind gusts. Although the integral exposure is not exceeding legal limits, the short peaks of radioactivity around the gate-monitor detectors trigger ”false” alarms.

As a consequence of this observation is that the proton beam intensity must remain limited to 2 μA or half of the available pulses with 3×10^{13} protons under such weather conditions when the gates are open (working hours). The present wind speed and direction can be obtained from one of the meteorological stations of the RAMSES system.

6 Summary

In order to keep releases of short-lived beta emitters from the Meyrin site well under the optimisation threshold, the amount of protons taken by ISOLDE targets must not exceed 2×10^{20} protons per year.

This limit allows ISOLDE operation at standard parameters with 3×10^{13} protons in one out of two PSB pulses, spaced by 1.2 s (1.25×10^{13} p s^{-1}) while occasionally using the full intensity from the PSB, when other users are not using all PSB cycles available.

Under weather conditions with strong winds ($v > 3$ m s^{-1}) from S and SW directions, the proton beam intensity must remain limited to the standard parameters during the opening hours of the gates of the *Sortie de marchandises* and of the tunnel between the Meyrin site and France.

MEDICIS Safety file 2016 (sent to the authorities)

CERN CH-1211 Geneva 23 Switzerland

EDMS NO.	REV.	VALIDITY
1541088	0.3	EN.CHECK

REFERENCE
MED-L-SF-0001

Date: 2016-09-01

SAFETY FILE – DESCRIPTIVE PART

Safety File for CERN-MEDICIS

ABSTRACT:

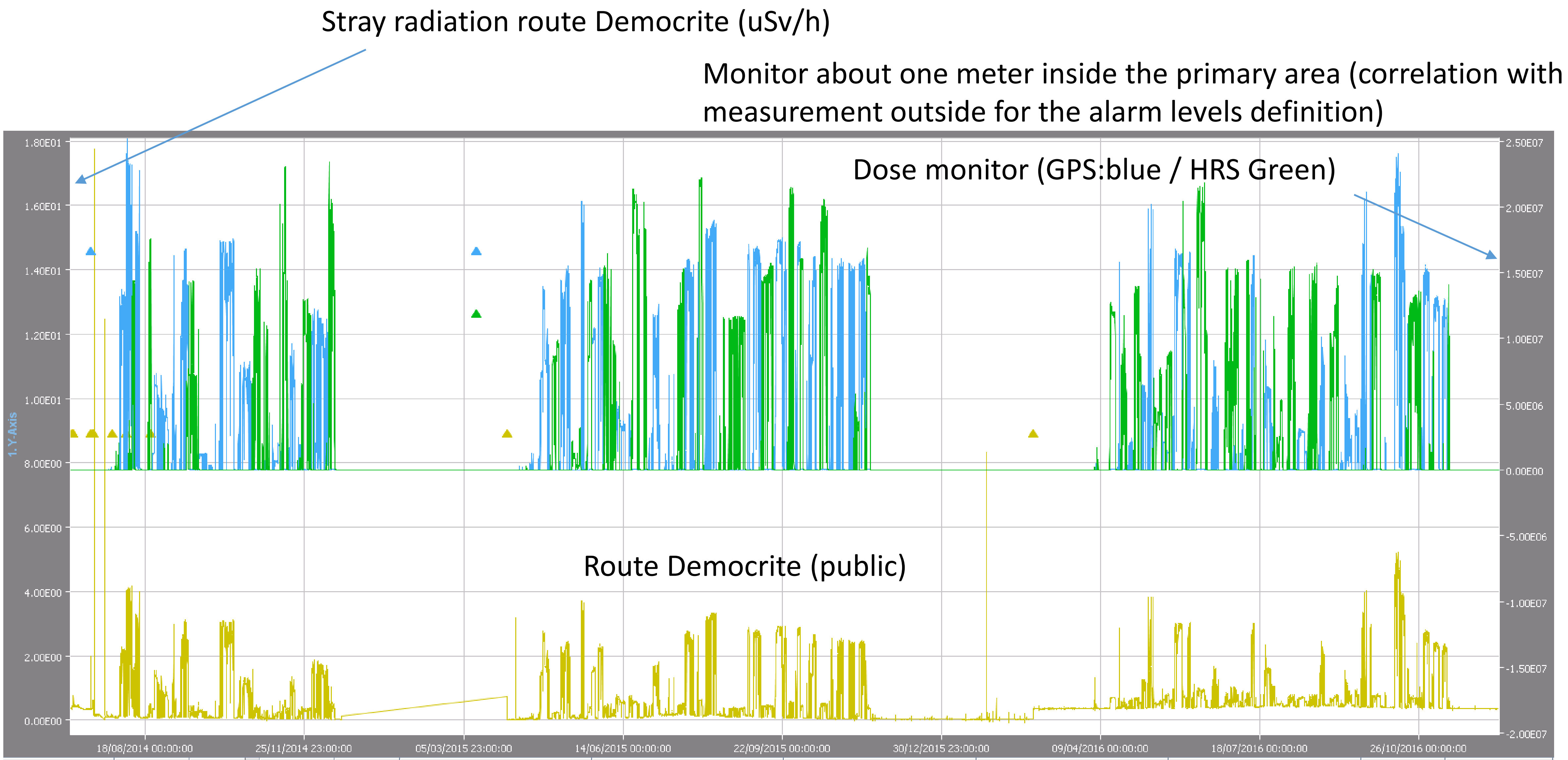
The aim of this document is to provide a description of the CERN-MEDICIS facility, dedicated to the production of radioisotopes for medical applications. The description of the facility is given in terms of safety, lifecycle and future evolutions, dismantling and disposal of its components.

2.3 BEAM PARAMETERS

CERN-MEDICIS targets are irradiated in ISOLDE's target area using the beam provided by the PS Booster (also called primary beam), as a result, the beam parameters will be the same for both ISOLDE and CERN-MEDICIS targets, being the maximum values 1.4 GeV and 2 μA. A detailed description of the primary beam's parameters can be found in document [1]. The CERN-MEDICIS facility has been conceived taking into account a possible upgrade of ISOLDE's primary beam up to 2.0 GeV and 6 μA, the CERN-MEDICIS equipment on the other hand will be modified in the context of a new project.

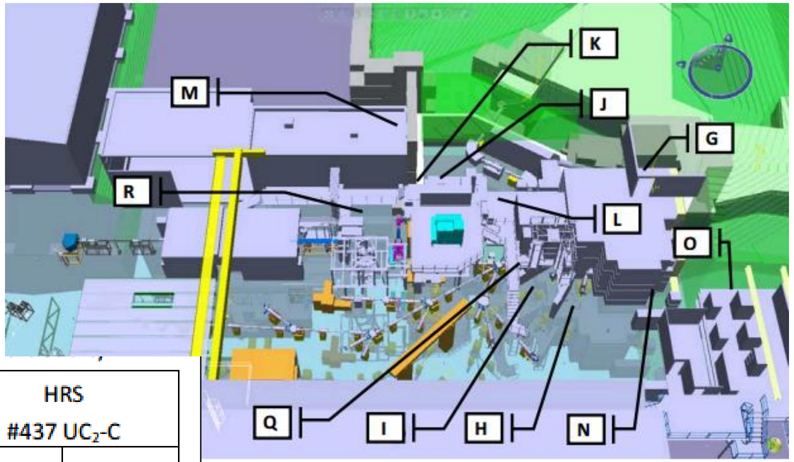
Operational radiation protection

- Problem of stray radiations
  - emergency exit on route Democrite
  - shielding weaknesses in the hall
- Stray radiation levels can be considered proportional to the beam intensity
- Radiation monitor alarm levels are derived from the area classification (cannot be increased)
- Gate monitor issues reported in 2006: seems not to be a problem in the last years (but it will be further checked)



Channel	Color	Unit	2nd Y-Axis	✓ Visible	Integral	Mean	Min	Max	Standard deviation	Thresholds	Prior param change
PAXIS301		µSv/h									23/02/2016
PMHIS201		µGy/h	✓	✓							23/02/2016
PMHIS202		µGy/h	✓	✓							23/02/2016
PAXIS302		µSv/h									23/02/2016
PAXIS303		µSv/h									23/02/2016
PATIS202		µSv/h		✓							23/02/2016
PAXIS201		µSv/h									23/02/2016

In the hall:



nSv/h per uA on target

Position		Zonage[1]	GPS #417 Ta		GPS #438 UC_2-C		GPS #440 UC_2-C		HRS #431 UC_2-C		HRS #437 UC_2-C	
			γ	n	γ	n	γ	n	γ	n	γ	n
A	Point gaz	ZNR	<LD	167	<LD	180	<LD	205	<LD	47	<LD	46
B	Parking	ZNR	<LD	<LD	<LD	<LD	<LD	<LD	-	-	<LD	<LD
C	Couloir 179/R-201	ZC SL	83	847	69	809	208	2 072	50	260	55	240
D	Point gaz h=7m	ZNR	<LD	52	34	119	-	-	<LD	84	-	-
E	Porte 902	ZNR	61	53	56	74	463	457	<LD	21	<LD	22
F	BTY IS2	ZNR	<LD	54	30	60	<LD	<LD	-	-	-	-
G	Sur blindage sép. GPS	ZS	6 801	[2]20 650	7 543	[2]21 273	17 147	[2]48 374	-	-	-	-
H	GHM	ZS	196	516	170	481	211	917	158	83	-	-
I	GLM	ZS	-	618	430	616	375	1 134	216	164	-	-
J	Local HT (sur blind.)	ZS	790	1 451	419	1 518	975	2 319	2 271	4 264	3 326	3 082
K	Local HT (porte)	ZS	331	1 977	177	1 757	419	2 522	715	3 138	443	2 473
L	Local RILIS	ZS	-	-	2 630	3 261	4 908	3 665	-	-	4 116	1 833
M	Local RF	ZS	-	-	58	213	-	-	-	-	<LD	39
N	Porte sép. GPS	ZS	-	-	409	413	328	430	-	-	-	-
O	Local ventilation	ZS	-	-	1 334	5 430	-	-	-	-	307	29
P	Verticale de BTY IS3	ZNR	-	-	-	-	-	-	<LD	<LD	47	365
Q	Porte séparateur HRS	ZS	-	-	-	-	-	-	-	-	162	485
R	Couloir REX-ISOLDE	ZS	-	-	-	-	-	-	-	-	43	100
S	Beam-Dump HRS	ZNR	-	-	-	-	-	-	-	-	390	8 692
T	Entre b/d et local HT	ZNR	-	-	-	-	-	-	-	-	235	2 834

[1] *ZNR = Zone non réglementée, ZS = Zone surveillée, ZC SL = Zone contrôlée à séjour limité*
[2] *Résultat à majorer par un facteur 1.5*

CH1211 Genève 23
Suisse

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RÉFÉRENCE
CERN-DGS-2010-006-RP-SN
Date : 30 August 2011

Survey Note

Evaluation du blindage de la zone cible ISOLDE

DOCUMENT PRÉPARÉ PAR :
M. DESCHAMPS
A. DORSIVAL
C. SAURY
DOCUMENT VÉRIFIÉ PAR :
J. VOLLAIRE
DOCUMENT APPROUVÉ PAR :
S. ROESLER

Environmental impact

- “Annual accounting”: sensitive to the integrated number of protons rather than instantaneous beam intensity
- ISOLDE is one facility on the Meyrin
- ISOLDE is the closest to the reference group
- Skyshine radiations and short lived radionuclides from air activation must be taken into account
- HRS is more penalizing for skyshine radiations (shielding weakness on top of the dump)

Environmental impact: Run 2012 ($1.3x10^{20}$ POT)

Gas

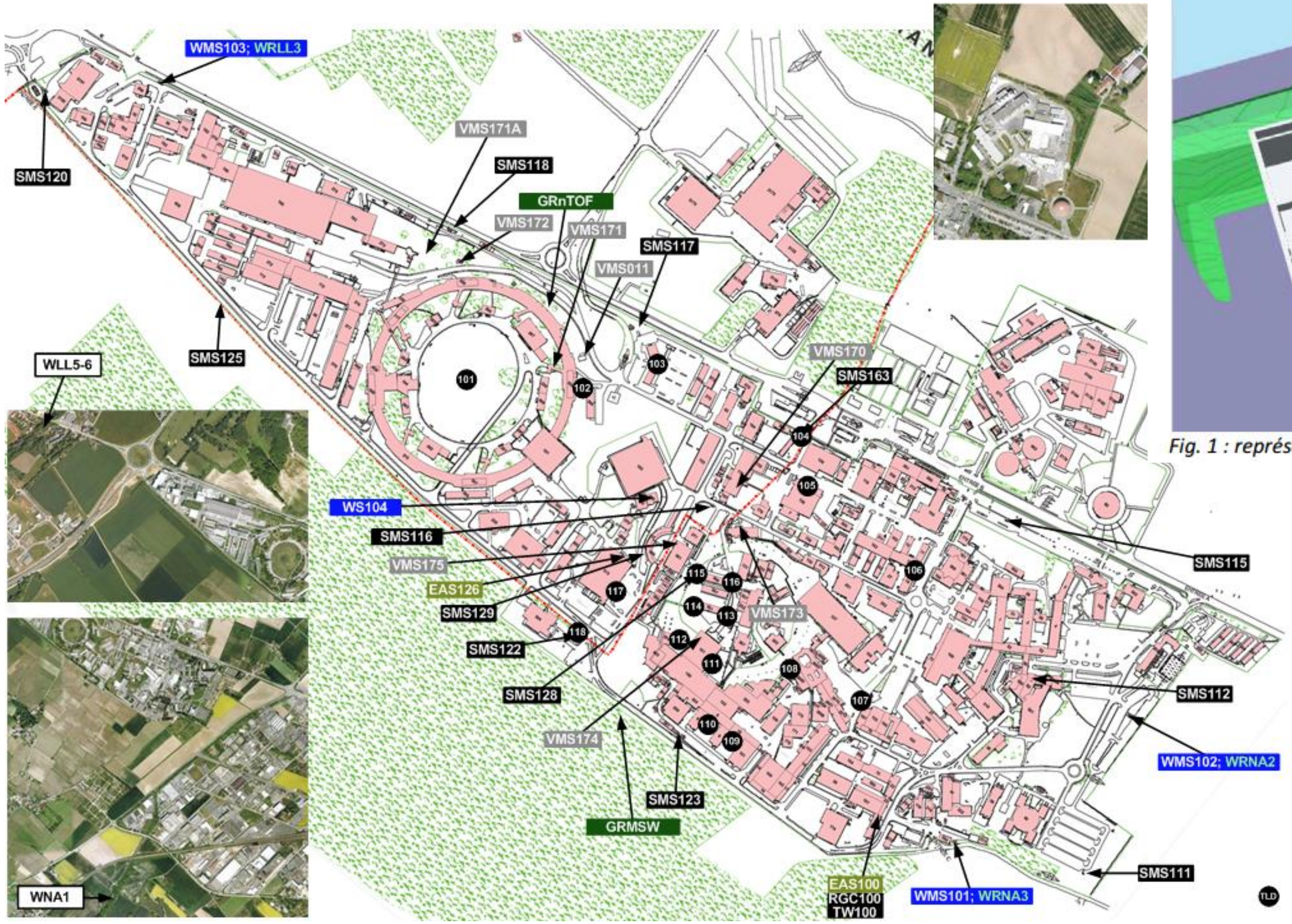
Scaling $2.0x10^{20}$ POT @ 1 GeV ~ $1.43x10^{20}$ POT @ 1.4 GeV

Site/Facility	Station	Release (m^3)	Short Lived (Bq)	^{7}Be (Bq)	Alpha (Bq)	Beta (Bq)	Tritium (Bq)	Dose (μSv)
Meyrin		**9.97E+08**	**5.22E+13**	**1.44E+09**	**6.16E+05**	**5.08E+07**	**9.32E+10**	**8.47**
ISOLDE	PMV170	7.9E+07	1.16E+13	6.74E+06	6.16E+05	5.47E+05	1.05E+10	3.86
PS Main Ring	PMV174	2.8E+08	2.56E+13	9.39E+08	< DL	3.32E+07	9.00E+09	3.06
n-TOF	PMV171	5.0E+06	6.86E+12	< DL	< DL	1.42E+04	3.45E+09	0.68
TT10 Injection West	PMV11	2.9E+08	4.53E+12	2.11E+08	< DL	8.73E+06	1.39E+10	0.41
PS BOOSTER	PMV175	2.7E+08	3.04E+12	2.79E+08	< DL	8.30E+06	1.24E+09	0.25
TT70 Transfer PS-SPS	PMV173	6.1E+07	5.19E+11	2.51E+04	< DL	< DL	5.51E+10	0.17
HIRADMAT	PMV70	7.1E+06	1.15E+10	4.24E+03	< DL	< DL	< DL	0.02
Prévessin		**4.68E+08**	**5.73E+12**	**8.34E+06**	**< DL**	**4.41E+05**	**1.17E+10**	**3.19**
TT20 Extraction North	PMV801	3.24E+07	4.68E+12	8.11E+06	< DL	3.89E+05	4.16E+09	3.06
SPS Main Ring BA3	PMV31	4.11E+08	9.20E+11	3.11E+04	< DL	< DL	7.55E+09	0.13
TDC2/TCC2	PMV802	**1.85E+08**	4.23E+09	5.00E+04	< DL	9.67E+03	< DL	0.00
SPS-4		1.19E+08	**1.24E+12**	**< DL**	**< DL**	**< DL**	**8.91E+08**	**0.52**
SPS-LHC TI8	PMV400	6.58E+07	1.22E+12	< DL	< DL	< DL	8.70E+08	0.45
CNGS	PMV43	**3.82E+08**	2.27E+10	< DL	< DL	< DL	2.13E+07	0.07
SPS-5	PMV51	**5.46E+08**	**2.37E+12**	**4.78E+05**	**< DL**	**9.03E+03**	**7.63E+09**	**0.41**
LHC-3	PMV903	**6.18E+08**	**2.16E+11**	**< DL**	**< DL**	**< DL**	**< DL**	**0.03**
LHC-5	PMV905	**6.69E+08**	**5.29E+11**	**< DL**	**< DL**	**< DL**	**< DL**	**0.22**
LHC-7	PMV907	**9.97E+08**	**1.00E+13**	**8.84E+04**	**< DL**	**< DL**	**< DL**	**4.99**
Maximum Dose								**8.47**

+227 MBq of radioactive iodine from ISOLDE ➔ < 0.2 μSv

IEFC presentation (2013) F. Malacrida

Stray radiations



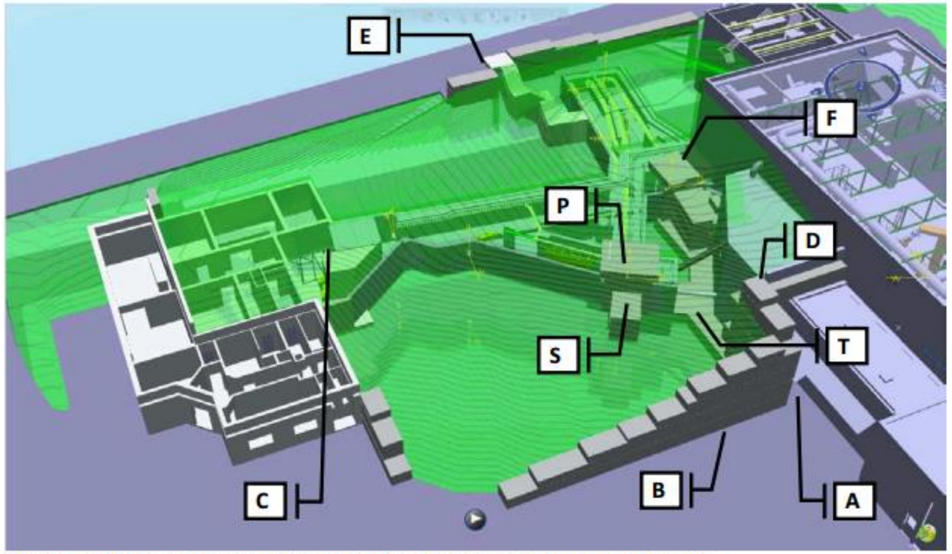
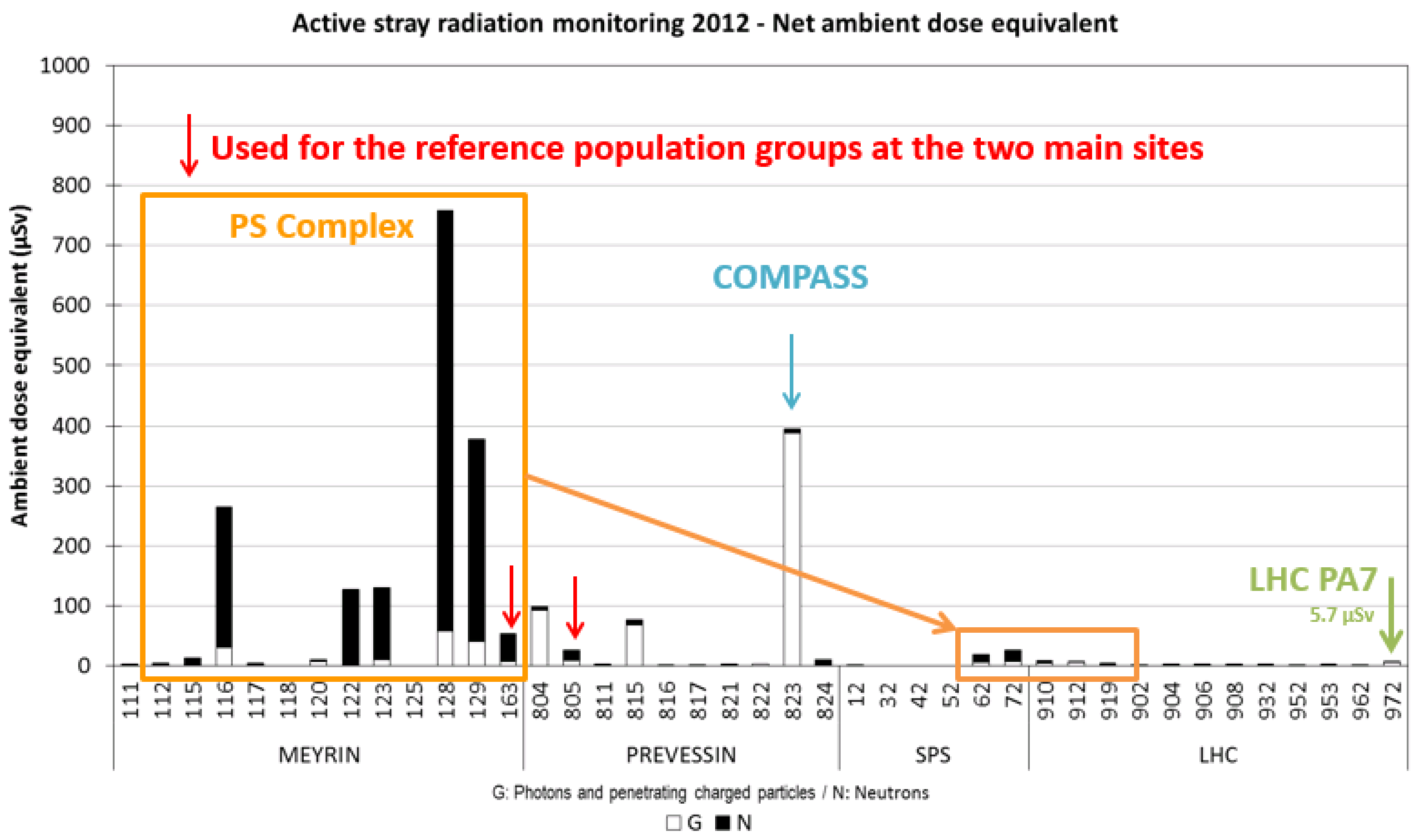


Fig. 1 : représentation graphique en 3D des points de mesures extérieurs

Stray radiations



IEFC presentation (2013) F. Malacrida

Preliminary Conclusions

- Hard limit of 2uA beam current was enforced in 2006 for operational reasons
- Any limit increase must be done within the current zonage (radiation monitor alarm levels) which could in some case be a problem at the emergency exit on route Democrite (GPS)
- The annual limit of 2.0×10^{20} POT was for a beam energy of 1 GeV (we should not consider it for 1.4 GeV)
- Increase of beam intensity may have an impact on cooling time necessary for intervention in case of technical problems
- Major modifications of beam parameters (Linac4/2 GeV…) should be the topic of a dedicated study and most likely be presented to the authorities