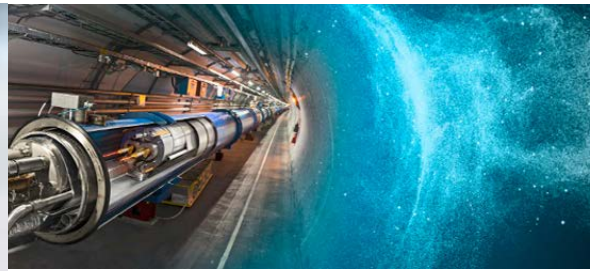

CERN


CERN

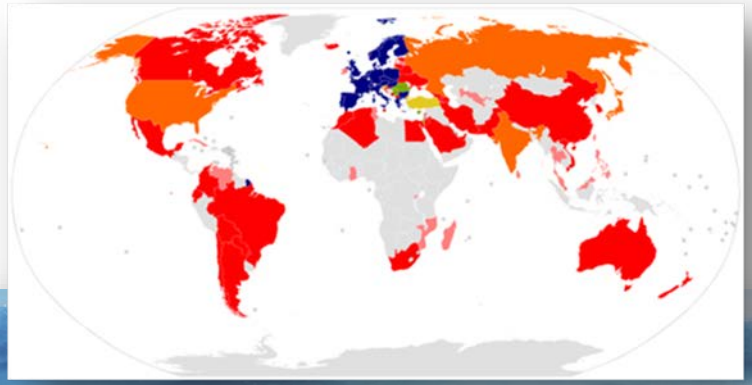
HSE
Occupational Health & Safety
and Environmental Protection Unit

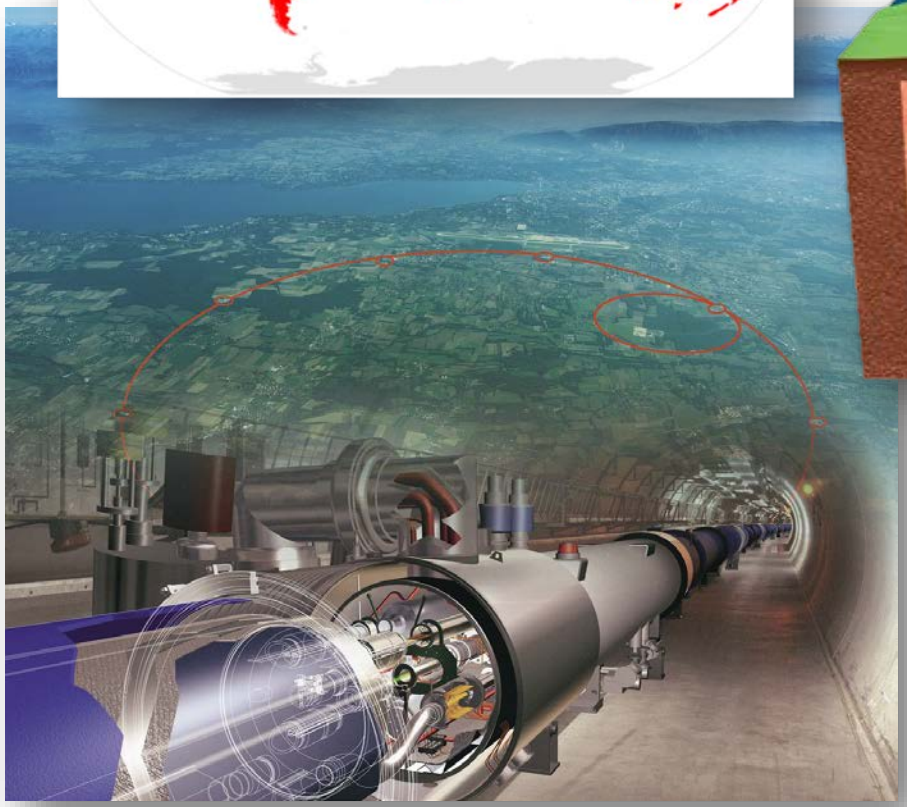
INTRODUCING THE NEW CERN CALIBRATION FACILITY

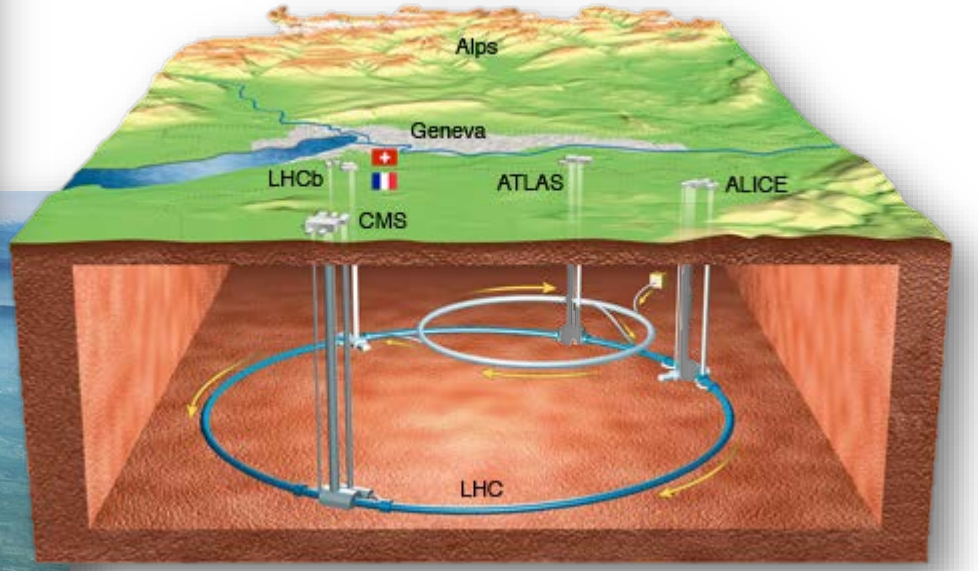
Pierre Carbonez / CERN



26th Mirion Technologies Training and Benchmarking Seminar Ft. Lauderdale
July 2016







Located on the French – Swiss border near Geneva, CERN is the world's largest particle physics laboratory

LHC: circumference 26,7 km, SPS: 7,3 km, CERN's Meyrin site 1 km long

Facts and figures

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- 15 000 Persons on the different sites every day
- 45 km of accelerator tunnels (30 mi)
- ~ 60 access points
- ~ 1000 radiologically classified areas

- 9000 DIS-1 distributed / calibrated every year
- 1500 DMC calibrated every year
- > 600 fixed ionization chambers
- > 1000 portable radiation monitoring devices

Calibration ? Why ?

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederazium svizra

Département fédéral de l'intérieur DFI
Office fédéral de la santé publique OFSP

941.210.5

développer tout | fermer tout

Ordonnance du DFJP sur les instruments de mesure des rayonnements ionisants

(OIMRI)

du 7 décembre 2012 (Etat le 1er janvier 2013)

Le Département fédéral de justice et police (DFJP),

vu les art. 5, al. 2, 8, al. 2, 16, al. 2, 17, al. 2, 24, al. 3, et 33 de l'ordonnance du 15 février 2006 sur les instruments de mesure (OIMes)[1], vu les art. 64 et 112 de l'ordonnance du 22 juin 1994 sur la radioprotection (ORaP)[2],

AUTORITÉ DE SÛRETÉ NUCLÉAIRE

Décrets, arrêtés, circulaires

TEXTES GÉNÉRAUX

MINISTÈRE DE L'EMPLOI, DE LA COHÉSION SOCIALE ET DU LOGEMENT

Arrêté du 26 octobre 2005 définissant les modalités de contrôle de radioprotection en application des articles R. 231-84 du code du travail et R. 1333-44 du code de la santé publique

ANNEXE 2

CONTRÔLE DES INSTRUMENTS DE MESURE MENTIONNÉS À L'ARTICLE R. 1333-7 DU CODE DE LA SANTÉ PUBLIQUE ET À L'ARTICLE R. 231-84 DU CODE DU TRAVAIL

1° *Cadre du contrôle*

A bit of history… Building 172

Old calibration laboratory for RP instruments

Located next to entrance B behind the parking

Next to the new SC visit point

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Occupational Health & Safety
and Environmental Protection Unit

B. 172 - Old RP Calibration facility.

Authorities tolerate that we operate our own calibration facility although it is not officially accredited in FR or CH (underway for the new one).

It housed low and high dose gamma irradiators and a Pu-Be source for neutron irradiations.

The building was also used for training, performance tests and research applications.

Material tested

The quantity of instruments to be calibrated is increasing each year.

- 800 portable instruments calibrated /year

- 1500 electronic dosimeters calibrated / year

- 700 personal dosimeters calibrated /month

- Test facility for research monitors.

- Test facility for new instruments.

Irradiators and sources (old lab)

Two irradiators and 30 radioactive sources covering a wide range of doserates and energies. (α,β,γ,n)

ID	Isotope		Activité	D	Description	Emplacement	Utilisateur
159	Pu-Be	OLD	76.90 GBq	2	Source neutron	172/1-004	PIERRE CARBONEZ
474	Am-Be	OLD	10.25 GBq	2	Source Neutron type AMM300	172/1-004	PIERRE CARBONEZ
475	Am-Be	OLD	10.25 GBq	2	Source Neutron 7.7E+5 n/s t...	172/1-004	PIERRE CARBONEZ
1120	Pu-Be	OLD	1.85 TBq	2	Source neutron	172/1-004	PIERRE CARBONEZ
1665	Co-60	OLD	4.38 GBq	2	Source d'irradiation Gamma ...	172/1-004	PIERRE CARBONEZ
2045	Cs-137	OLD	906.94 GBq	2	Source d'irradiation gamma	172/1-004	PIERRE CARBONEZ
2407	Am-241	OLD	495.01 MBq	2	Source low energy gamma (ti...	172/1-004	PIERRE CARBONEZ
2619	Am-241	OLD	177.32 GBq	2	Source irradiation gamma lo...	172/1-004	PIERRE CARBONEZ
3470	Am-Be	OLD	360.21 MBq	2	STD neutron source	172/1-004	PIERRE CARBONEZ
3559	Am-241	OLD	91.62 Bq	0	Source Alpha Hand Reference	172/1-004	PIERRE CARBONEZ
3609	Cs-137	OLD	77.26 GBq	2	Source d'irradiation gamma	172/1-004	PIERRE CARBONEZ
3717	Cs-137		26.44 MBq	1	Industrial gamma source	172/1-004	PIERRE CARBONEZ
3723	Co-60		10.81 MBq	1	Industrial gamma source	172/1-004	PIERRE CARBONEZ
3739	Cs-137		1.32 GBq	2	Industrial gamma source	172/1-004	PIERRE CARBONEZ
3740	Cs-137		10.73 GBq	2	Industrial gamma source	172/1-004	PIERRE CARBONEZ
3741	Cs-137		158.79 MBq	2	Industrial gamma source	172/1-004	PIERRE CARBONEZ
3742	Sr-90	OLD	4.01 kBq	0	Source Beta hand reference	172/1-004	PIERRE CARBONEZ
3743	Sr-90		1.62 kBq	0	Source Beta Hand reference	172/1-004	PIERRE CARBONEZ
3802	Cl-36		410.99 Bq	0	Calibration source for wide...	172/1-006	PIERRE CARBONEZ
3893	Sr-90		24.46 MBq	2	UNIDOS test source	172/1-004	PIERRE CARBONEZ
3898	Am-241		18.05 Bq	0	Source calibration alpha fo...	172/1-004	PIERRE CARBONEZ
3899	Cl-36		398.99 Bq	0	Wide area calibration source	172/1-004	PIERRE CARBONEZ
3900	Cl-36		89.60 Bq	0	Wide area calibration source	172/1-004	PIERRE CARBONE
3955	C-14		1.49 kBq	0	Source B- type CFRB8066	172/1-004	PIERRE CARBONE
3981	Cs-137		23.75 kBq	0	Source etalon gamma STD	172/1-004	PIERRE CARBONE
3982	Co-60		8.29 kBq	0	Source Etalon Gamma STD	172/1-004	PIERRE CARBON
4066	Cf-252		2.03 MBq	1	Source Neutron type CVN3	172/1-004	PIERRE CARBON
4248	Co-60	OLD	2.59 kBq	0	Wide area calibration source	172/1-004	PIERRE CARBO
4249	Am-241	OLD	784.92 Bq	0	Wide area calibration source	172/1-004	PIERRE CARBO
4250	Cl-36	OLD	999.99 Bq	0	Wide area calibration source	172/1-004	PIERRE CARB

NEED FOR CHANGE…

- Increasing number of mechanical system failures
- Increasing number of control system failures (de
- Operators are taking doses to repair the system
- No backup solution in case of electronic failure
- Building showed already signs of fatigue 4 ye

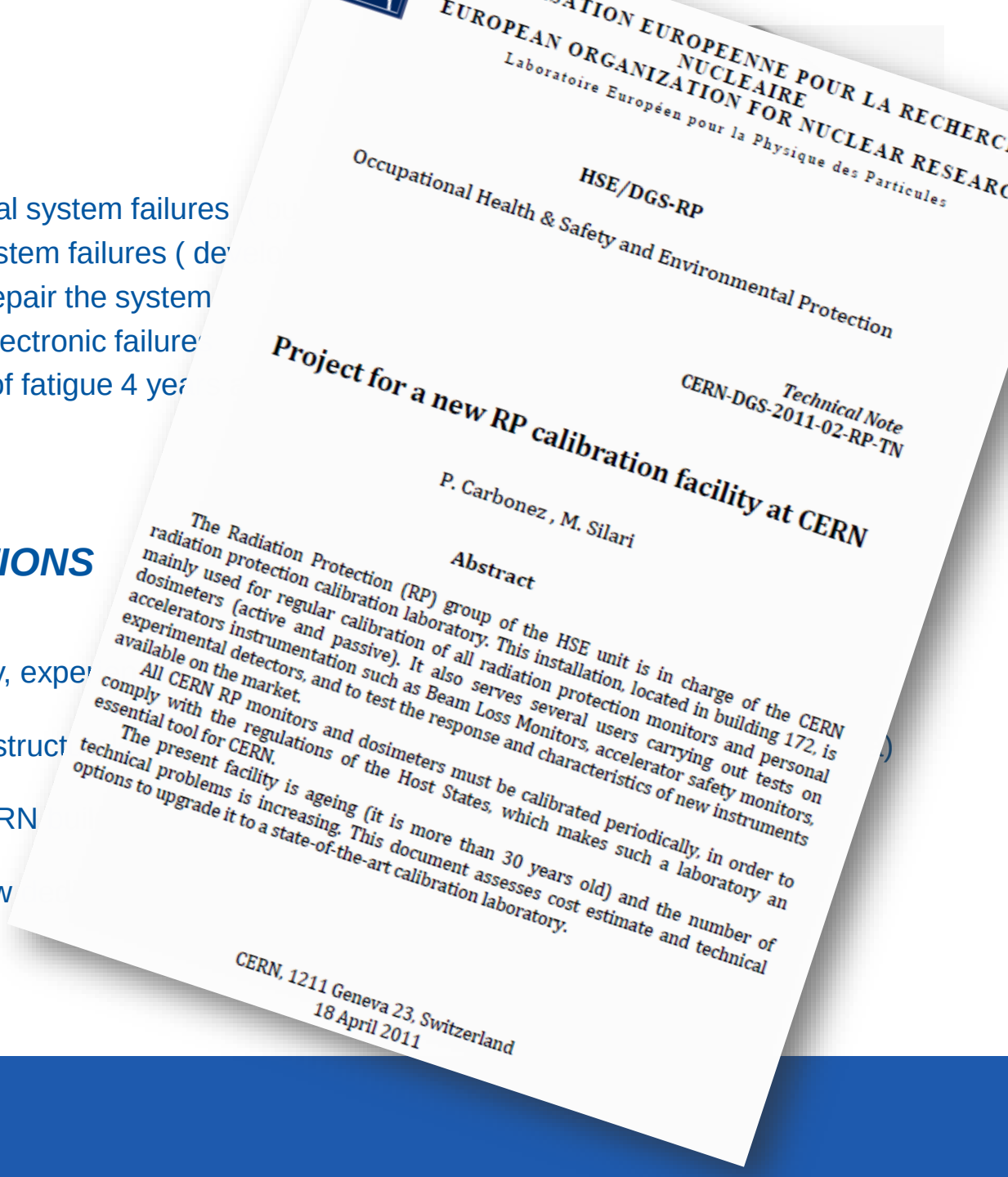
OPTIONS

Option 1 : Outsourcing (loss of flexibility, expe

Option 2: Consolidation of the facility (struct

Option 3: New facility in an existing CERN

Option 4: Set up a project to build a new



ORGANISATION EUROPEENNE POUR LA RECHERCHE NUCLEAIRE
EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
Laboratoire Européen pour la Physique des Particules

HSE/DGS-RP

Occupational Health & Safety and Environmental Protection

Technical Note
CERN-DGS-2011-02-RP-TN

Project for a new RP calibration facility at CERN

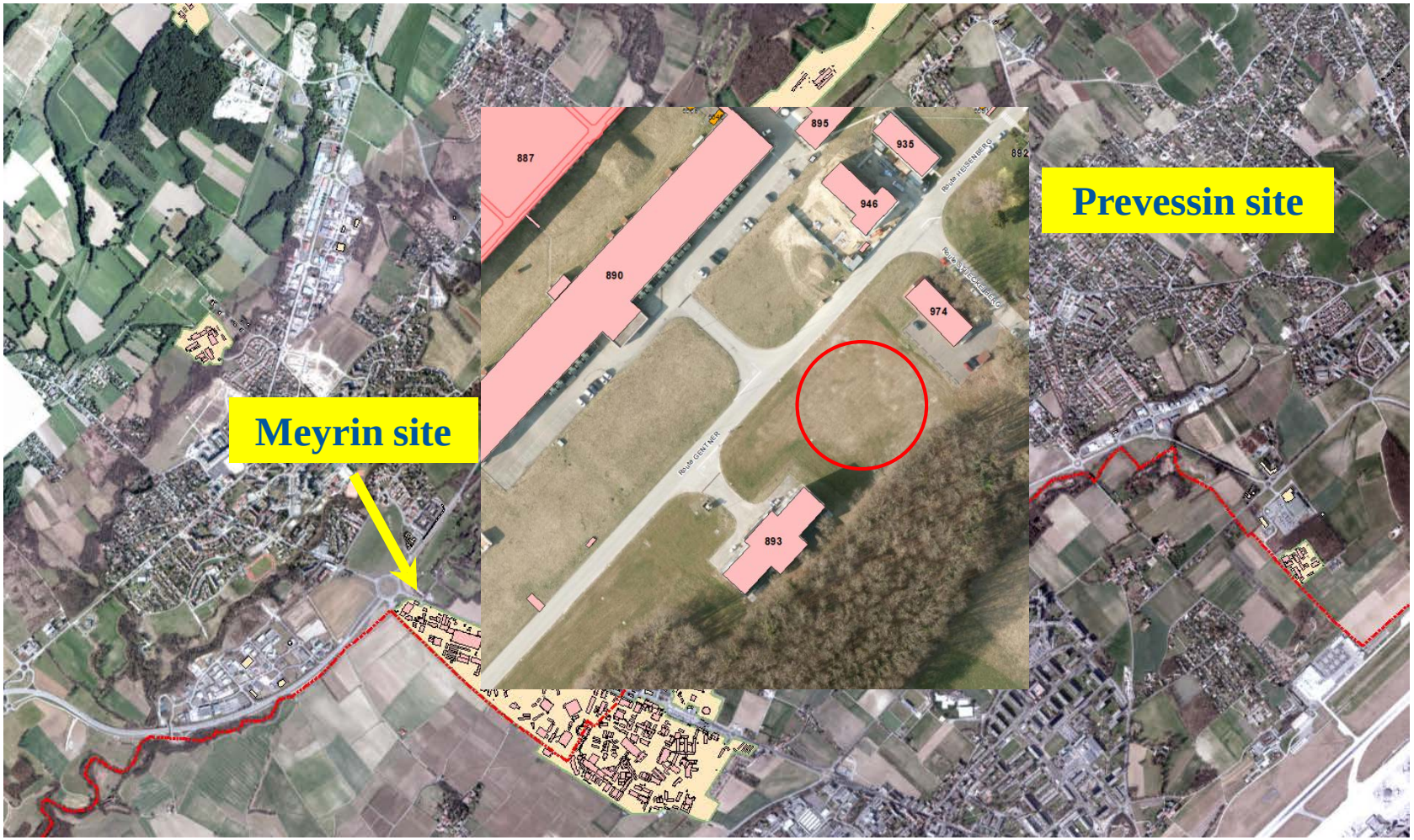
P. Carbonez , M. Silari

Abstract

The Radiation Protection (RP) group of the HSE unit is in charge of the CERN radiation protection calibration laboratory. This installation, located in building 172, is mainly used for regular calibration of all radiation protection monitors and personal dosimeters (active and passive). It also serves several users carrying out tests on accelerators instrumentation such as Beam Loss Monitors, accelerator safety monitors, experimental detectors, and to test the response and characteristics of new instruments available on the market.
All CERN RP monitors and dosimeters must be calibrated periodically, in order to comply with the regulations of the Host States, which makes such a laboratory an essential tool for CERN.
The present facility is ageing (it is more than 30 years old) and the number of technical problems is increasing. This document assesses cost estimate and technical options to upgrade it to a state-of-the-art calibration laboratory.

CERN, 1211 Geneva 23, Switzerland
18 April 2011

Find a location



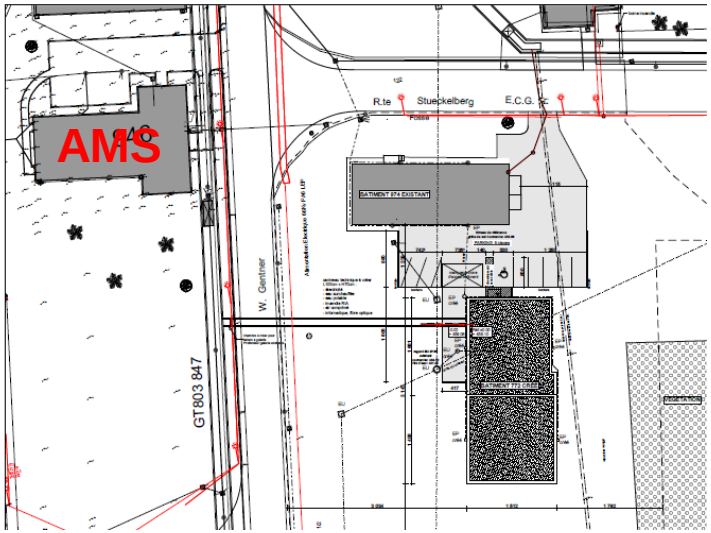
Design constraints : CERN area classification

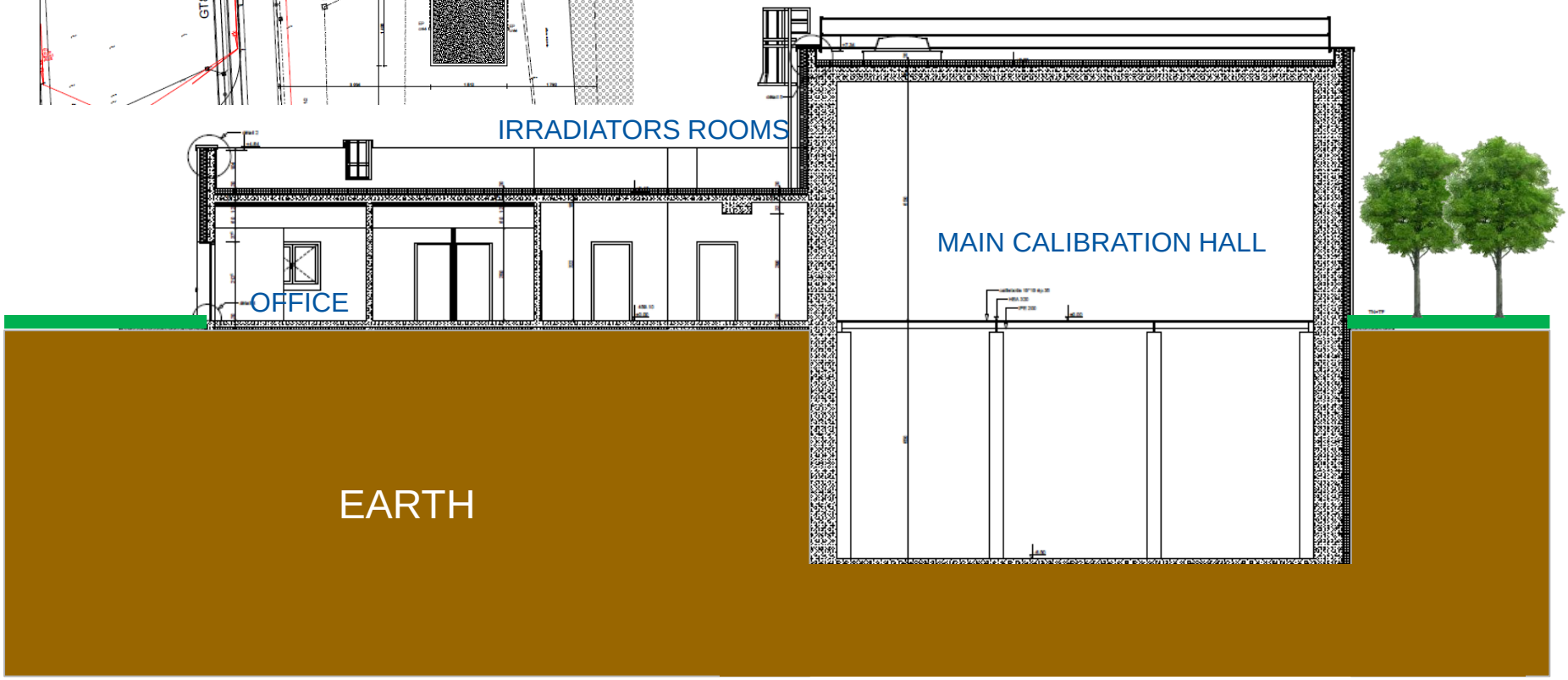
Unit conversion :

0,5 uSv = 50 urem
3 uSv = 300 urem
10 uSv = 1 mrem
1 mSv = 100 mrem

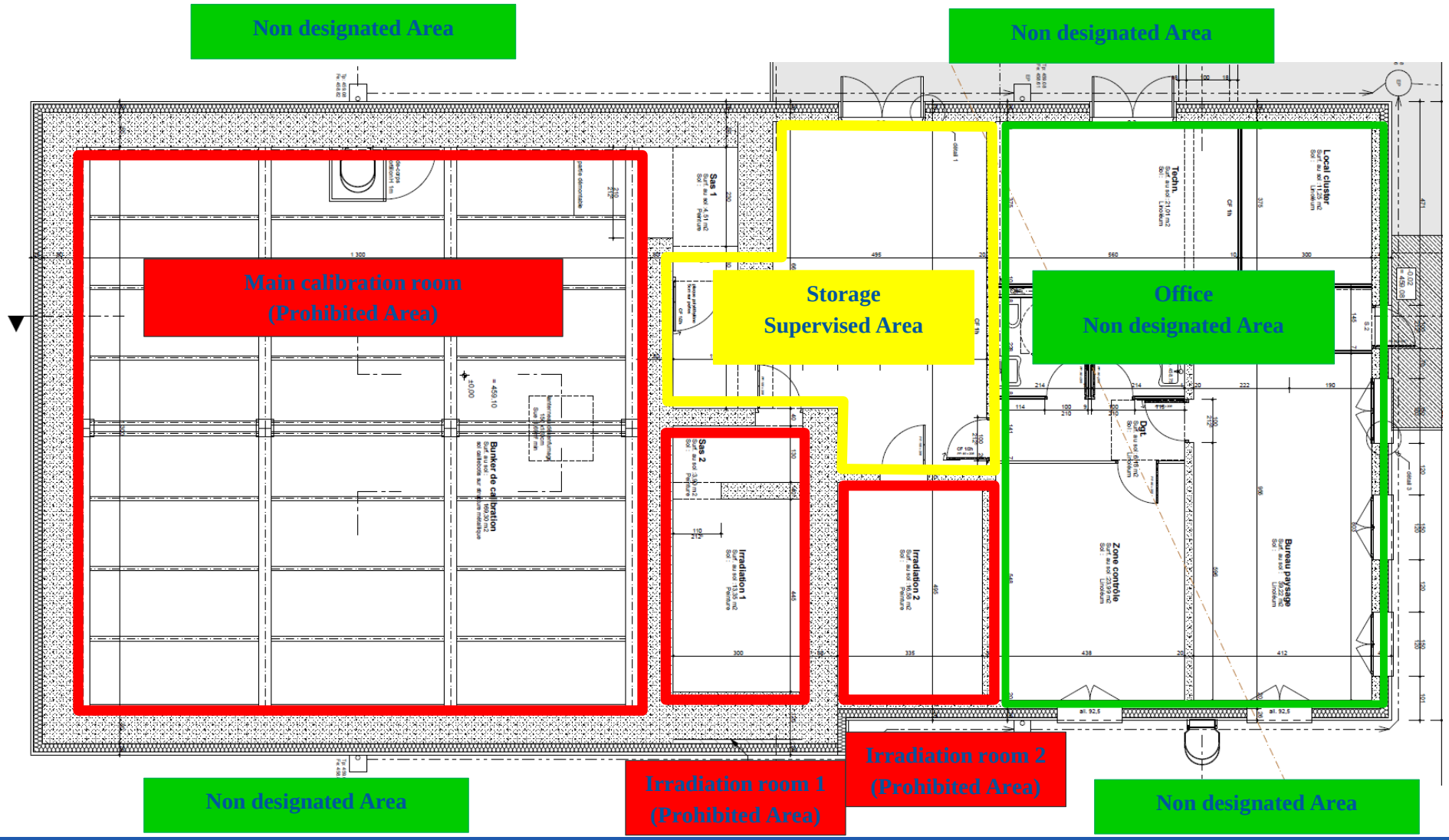
	Area	Dose limit [year]	Ambient dose equivalent rate	
			Permanent	Low occupancy
Radiation Area	Non-designated	1 mSv	0.5 µSv/h	2.5 µSv/h
	Supervised	6 mSv	3 µSv/h	15 µSv/h
	Simple	20 mSv	10 µSv/h	50 µSv/h
	Limited Stay	20 mSv		2 mSv/h
	High Radiation	20 mSv		100 mSv/h
	Prohibited	20 mSv		> 100 mSv/h
				Controlled Area

Location & Side View

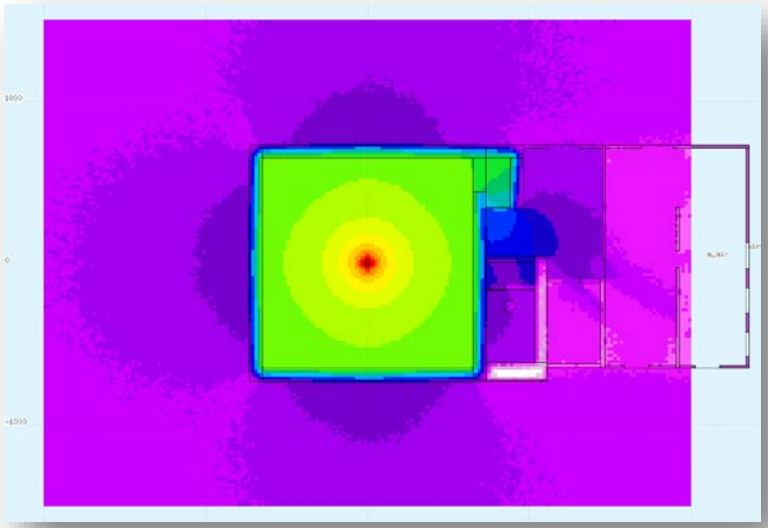


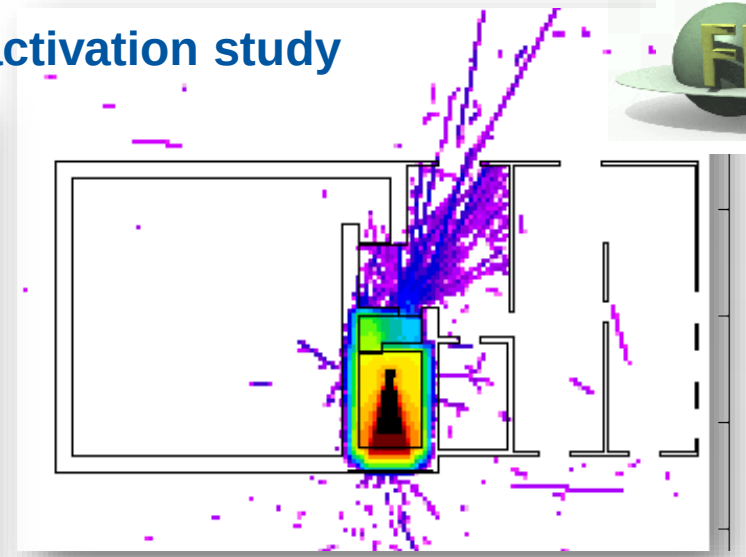


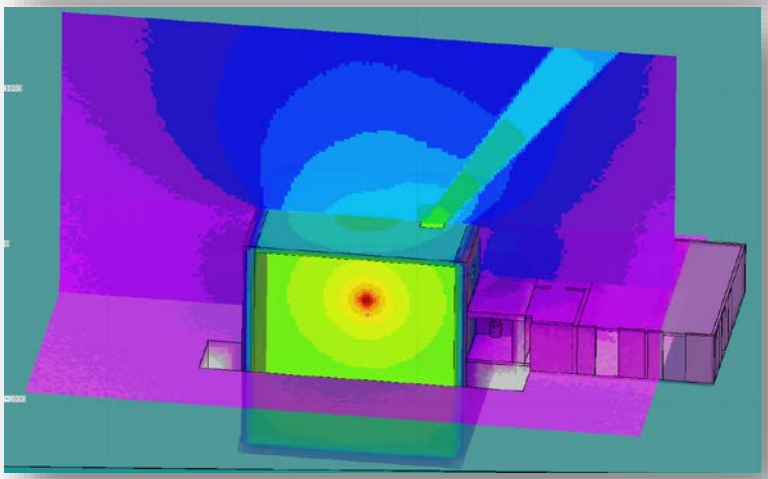
Facility classification

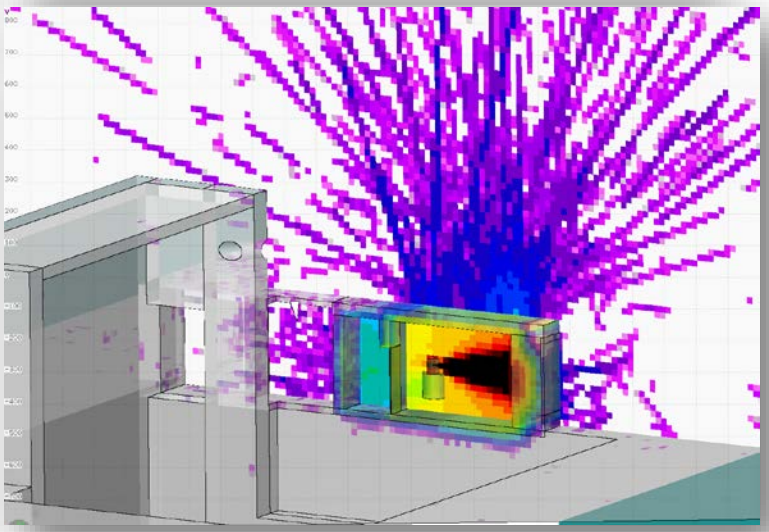


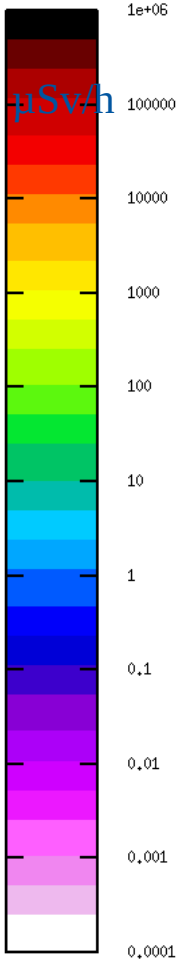
Calibration facility shielding and activation study





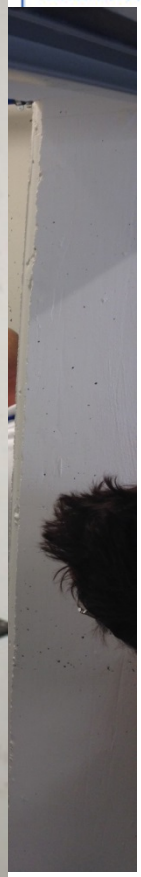


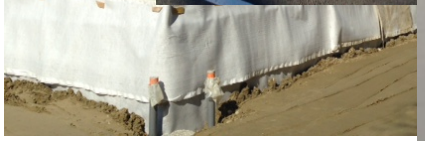




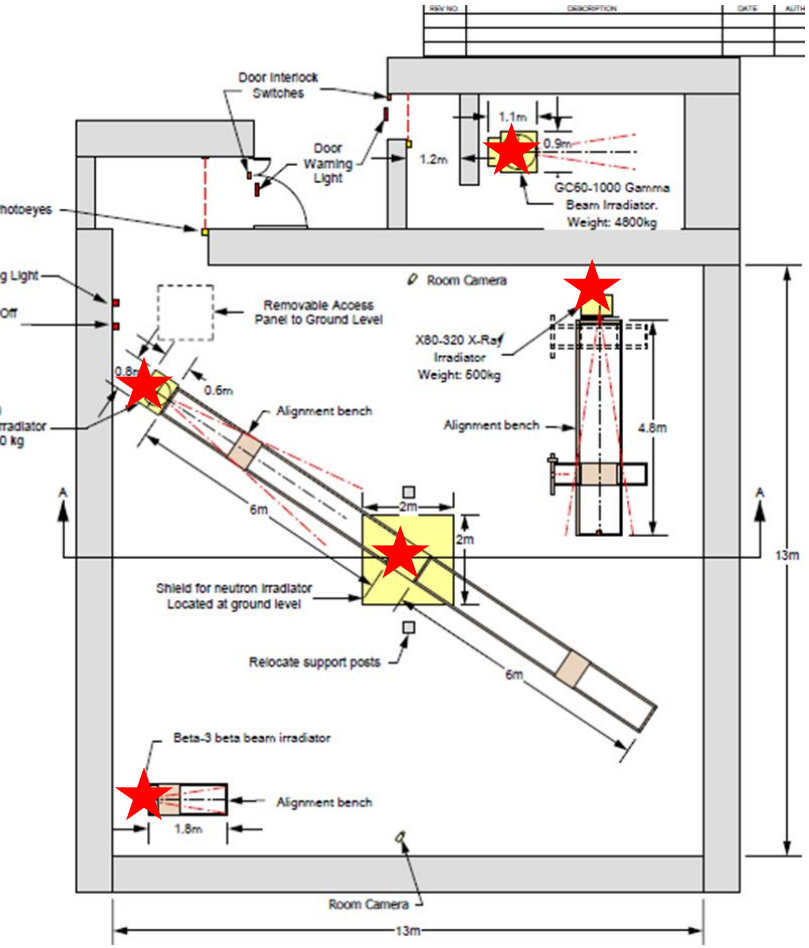
Simulations performed with CERN Fluka simulation software (Monte Carlo) by Mr F Pozzi


HOPEWELL DESIGNS INC





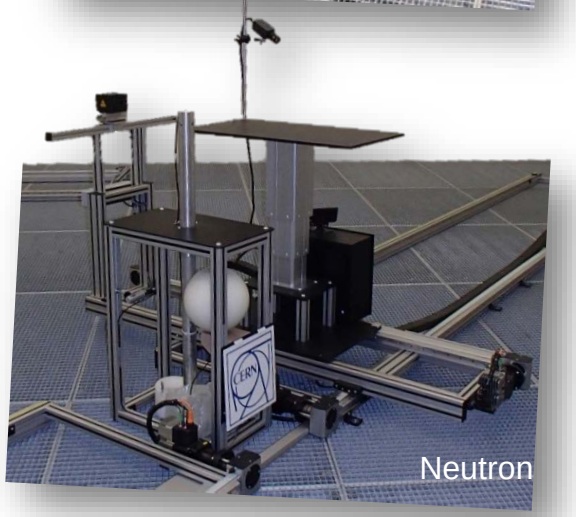
Disposition of the irradiators




Gamma


Beta


X-ray


Neutron

New sources

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Gamma

Isotope	Activity SI	US
137-Cs	300 MBq	(0,008 Ci)
137-Cs	3 GBq	(0,08 Ci)
137-Cs	30 GBq	(0,8 Ci)
137-Cs	300 GBq	(8 Ci)
137-Cs	3 TBq	(80 Ci)

Isotope	Activity SI	US
60-Co	5 GBq	135 mCi
60-Co	10 TBq	270 Ci

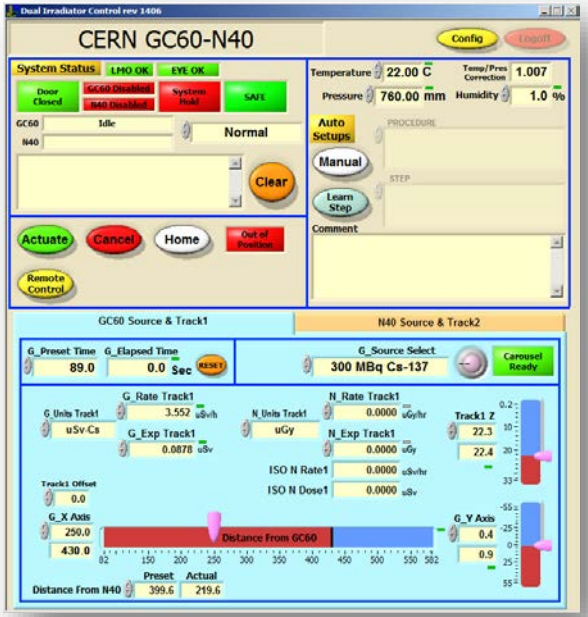
Neutron

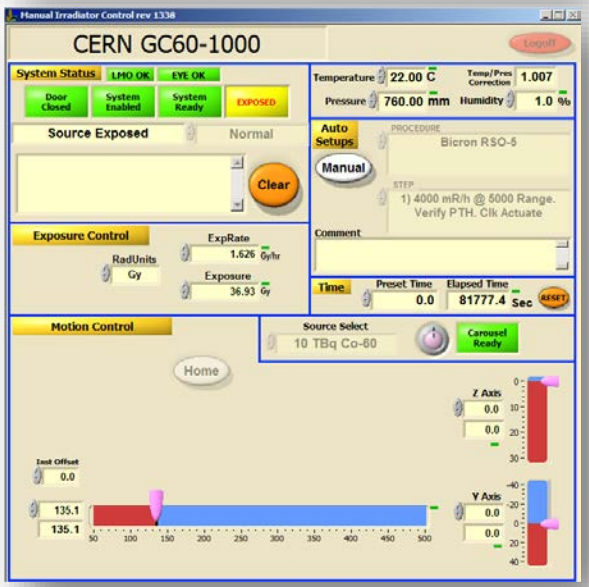
Isotope	Activity SI	US
Am-Be	100 MBq	2,7 mCi
Am-Be	10 GBq	0,27 Ci
Am-Be	100 GBq	2,7 Ci
Am-Be	1 TBq	27 Ci

3 Sv/h at 50 cm

300 Rem at 1,64 ft

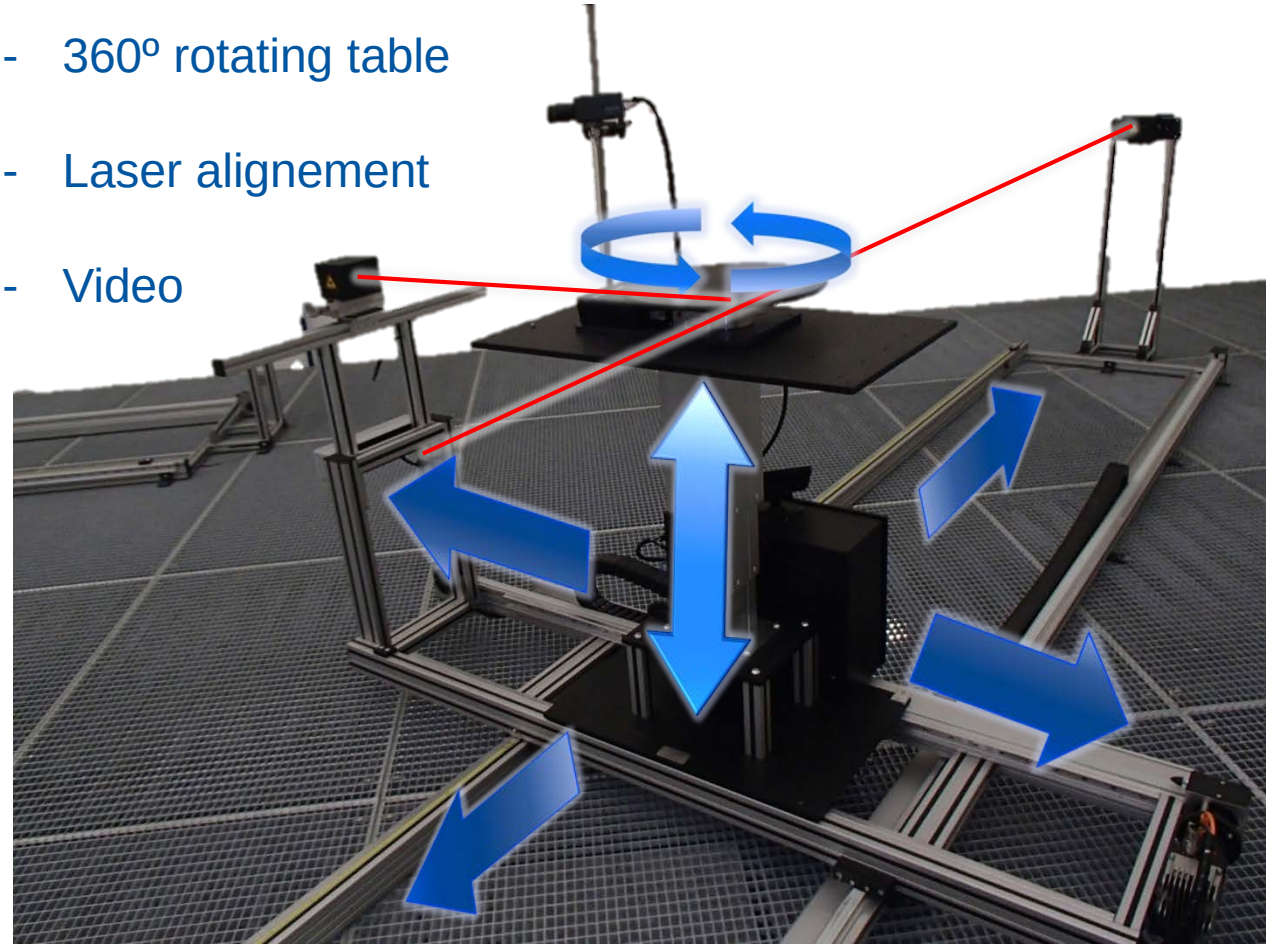
Control Room





Linear positioning system

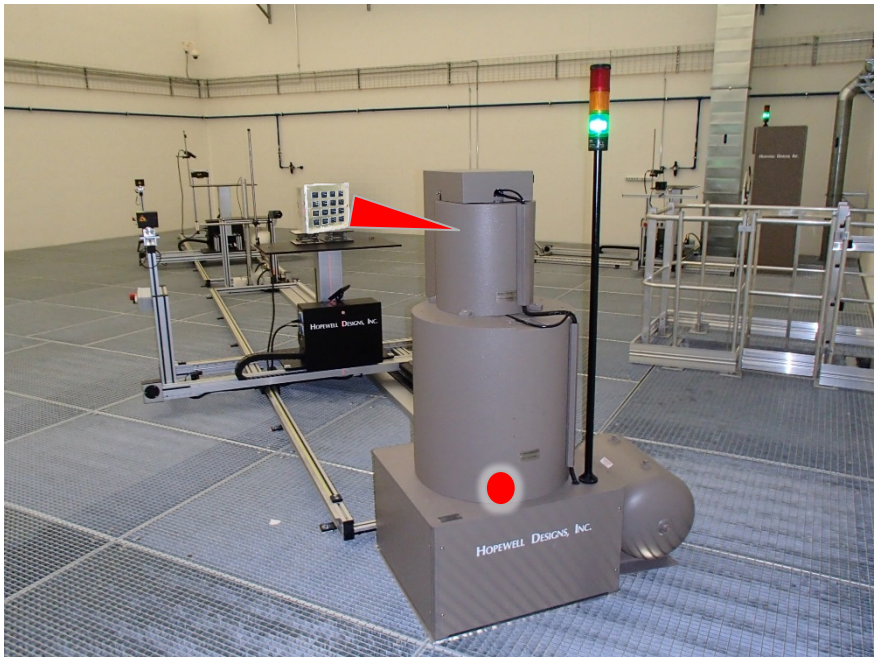
- 3 axis : X, Y, Z
- 360º rotating table
- Laser alignement
- Video



How are DIS dosimeter calibrated ?

The dosimeter are put on the calibration phantom together with 15 other friends.

Iso-slab phantom



600 to 800 DIS each month

Unit conversion :

800 uSv = 80 mrem
8000 uSv = 800 mrem

Reset : 5/10 min per dosimeter

Reading :if over 10% deviation =>

8000 uSv (15 min)

Calibration Process

Reading and calibration factor adjustment

8000 uSv (15 min)

Reading :If over 5% deviation =>

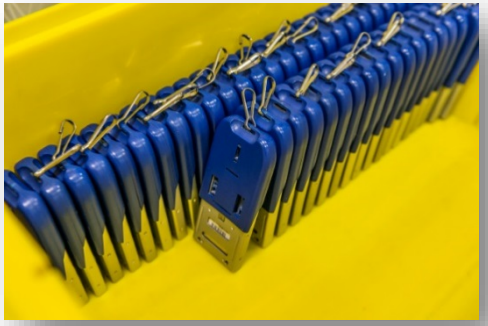
800 uSv (4 min)

Reading and calibration factor adjustment

800 uSv (4 min)

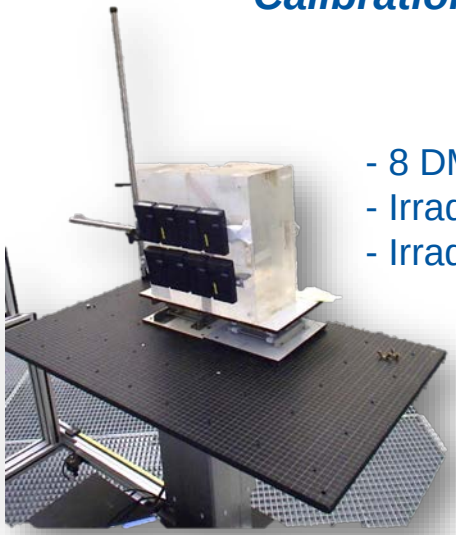
Annealing 8h

Final reset



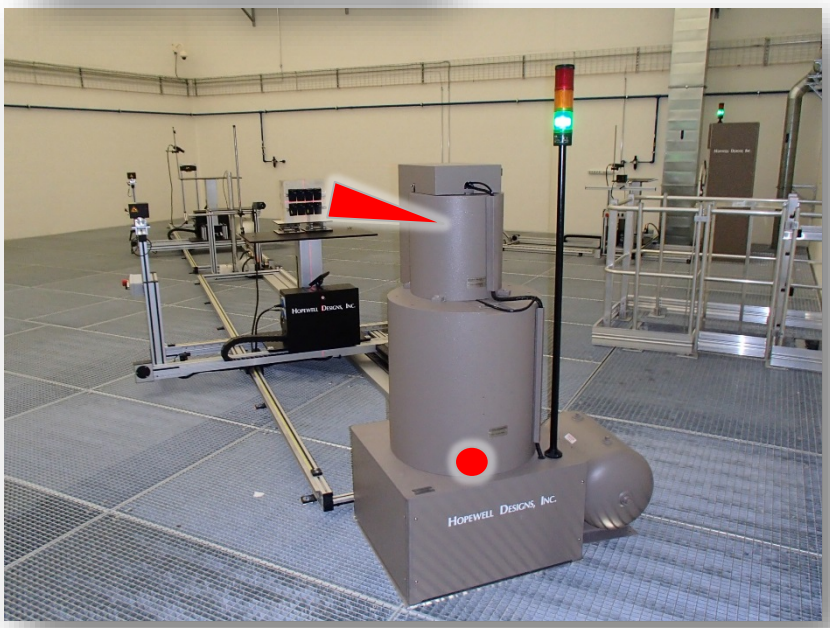
Assignment

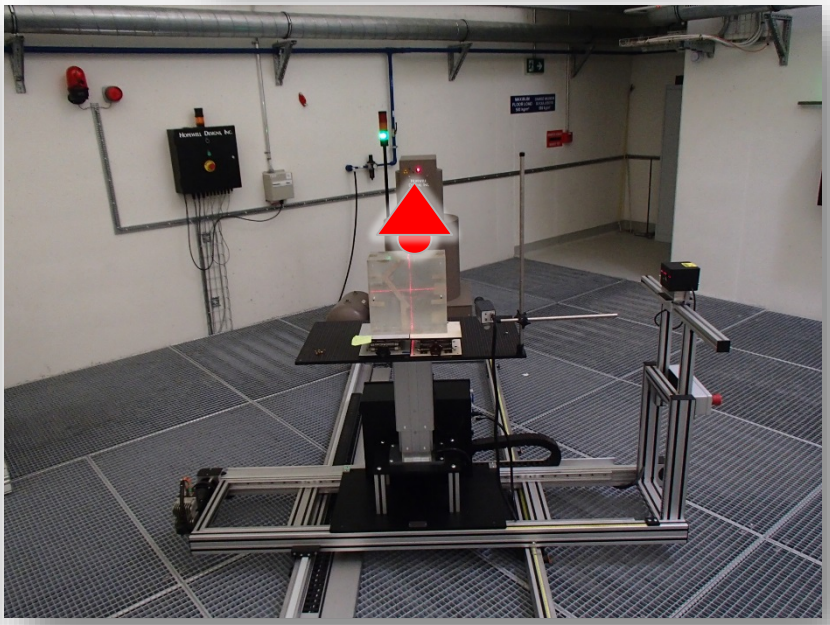
Calibration of DMC 2000 / 3000



- 8 DMC a the time
- Irradiation at 500 uSv (50mrem)
- Irradiation at 2 mSv (200mrem)

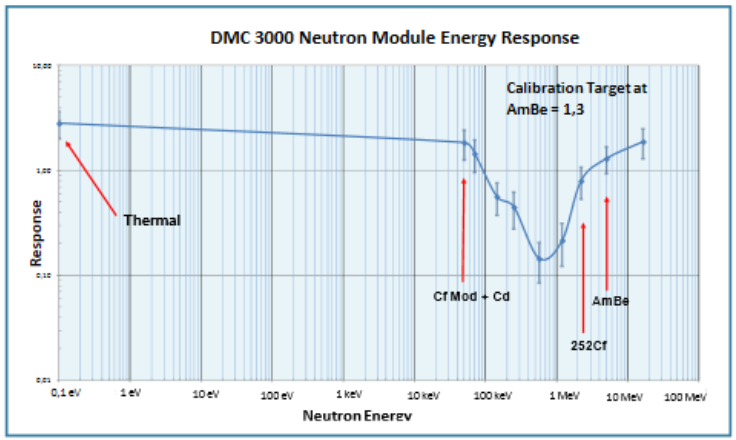
Tolerance +/- 15%

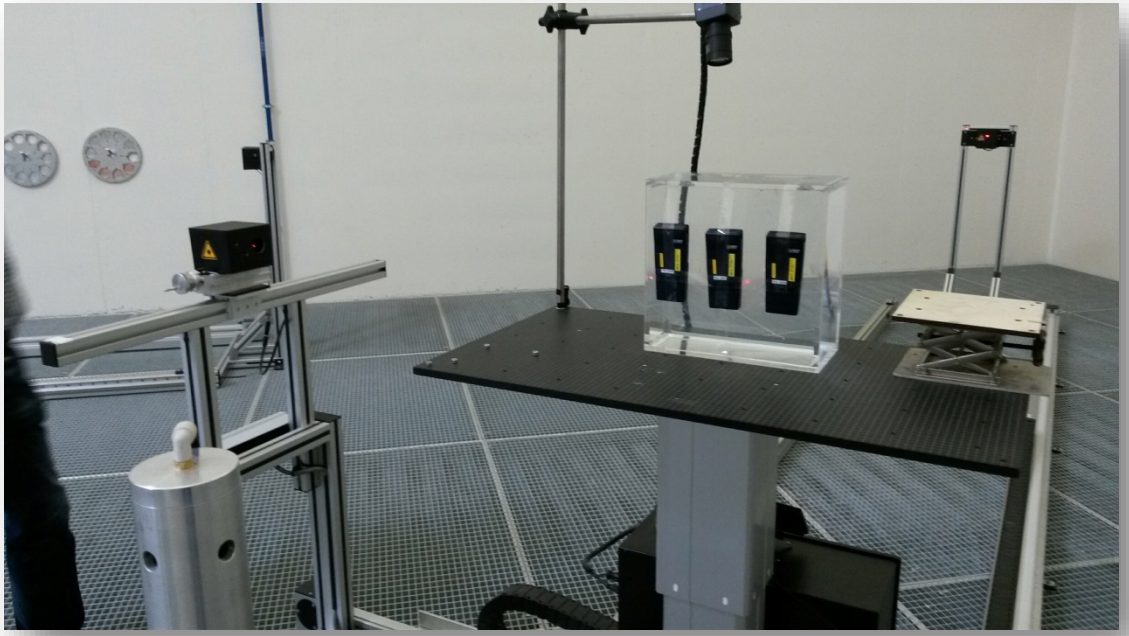




Test of “new” products available on the market

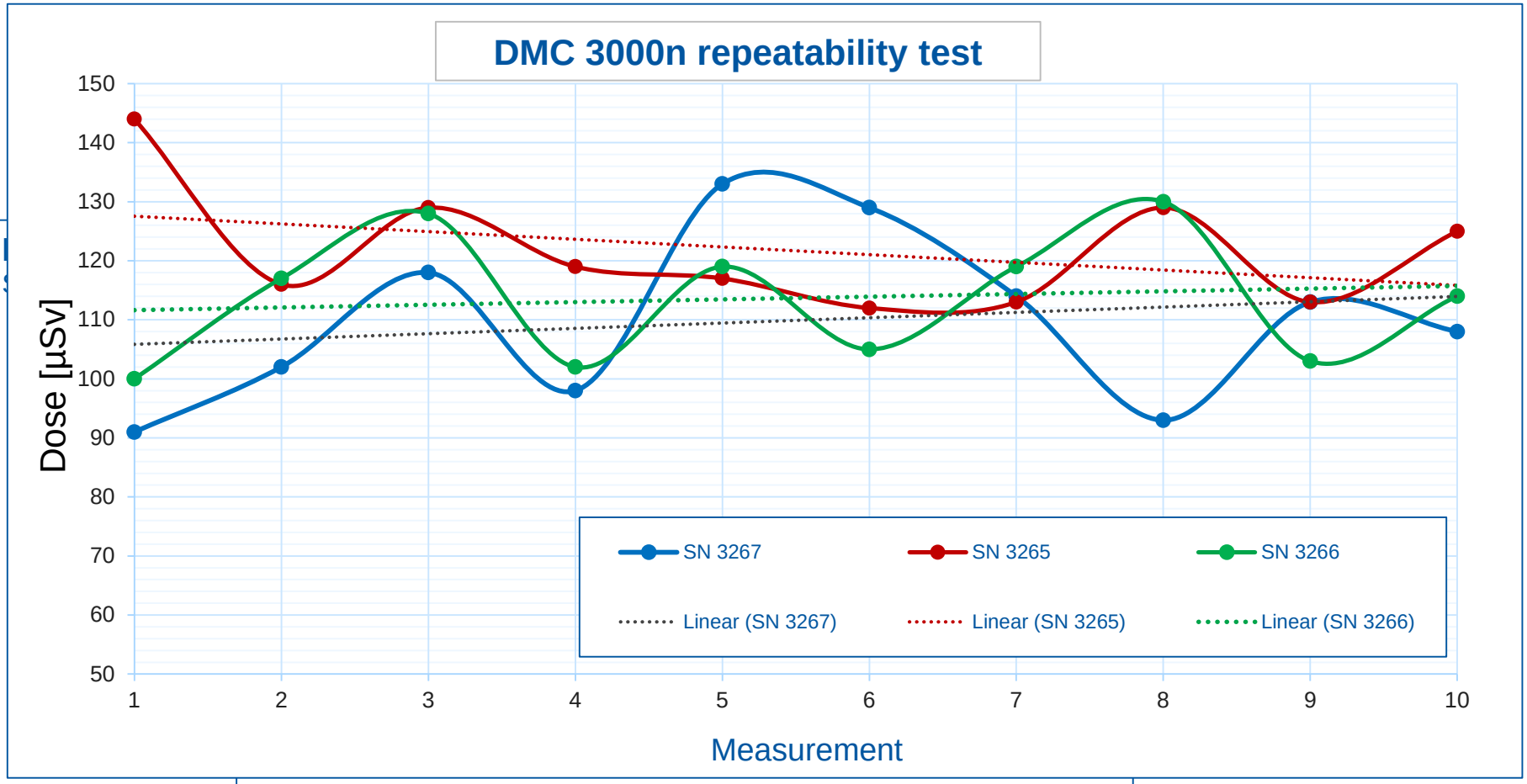
DMC 3000 + Neutron module

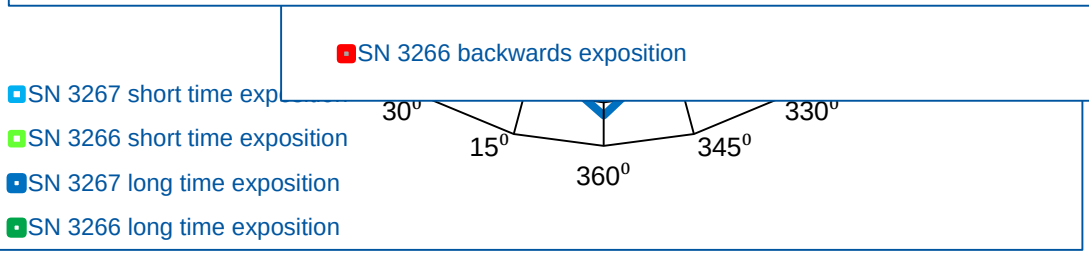




PHYSICAL CHARACTERISTICS

- **Compliant with IEC 61526 Ed. 3, ANSI 42.20(*)**
  (*) isotropy 241Am and 137Cs with ± 75° angle
- **Measurement range *Hp*(10) (DMC 3000 + module)**
  - X and gamma energy range: 15 keV to 7 MeV
  - Neutron energy range : 0.025 eV to 15 MeV
- **Display range *Hp*(10) Neutron**
  - Dose : from 1 µSv to 10 Sv (0.1 mrem to 1000 rem)
  - Dose rate : from 100 µSv/h to 10 Sv/h (10 mrem/h to 1000 rem/h)
- **Accuracy *Hp*(10) Neutron**
  - ≤ ± 10% (AmBe, 0.75 mSv/h, 75 mrem/h)
  - *Hp*(10) Typical Energy response from thermal to fast Neutron (see curve)


DMC 3000n repeatability test
Dose [µSv]
150
140
130
120
110
100
90
80
70
60
50
1
2
3
4
5
6
7
8
9
10
Measurement
SN 3267
SN 3265
SN 3266
Linear (SN 3267)
Linear (SN 3265)
Linear (SN 3266)

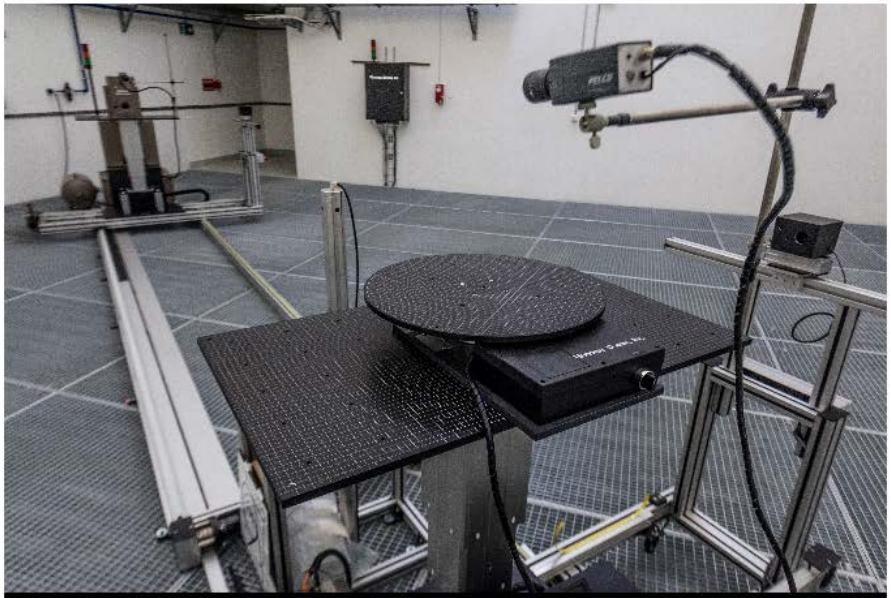

SN 3266 backwards exposition
SN 3267 short time exp
SN 3266 short time exposition
SN 3267 long time exposition
SN 3266 long time exposition
30⁰
330⁰
15⁰
345⁰
360⁰

Bulletin

HSE
Occupational Health & Safety
and Environmental Protection Unit

BUILDING 772 - CERN'S NEW CALIBRATION FACILITY FOR RADIATION PROTECTION INSTRUMENTS IS READY TO GO

Building 772 is becoming the new home of CERN's calibration facility for radiation protection instrumentation. The new laboratory in Prévessin will be a state-of-the-art calibration facility and the first of its kind in both France and Switzerland, offering a wide range of possibilities with respect to radiation fields and instrumentation.



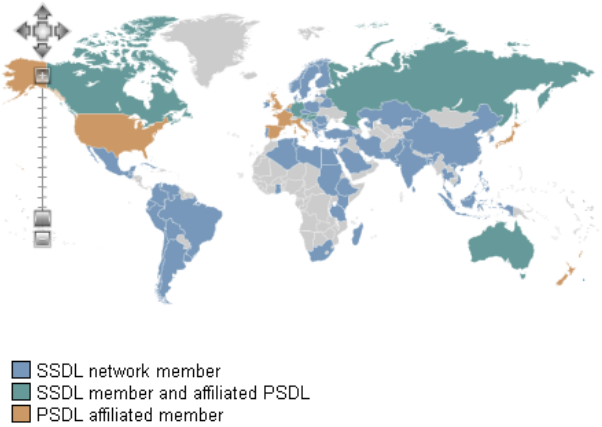
New four-axis calibration bench for radiation protection instruments.

Perspectives:

- Option to buy a 100 TBq 60-Co (2700 Ci)
- Calibration of the Beta and X fields
- Accreditation of the calibration laboratory
- Recognition by AIEA as SSDL

The IAEA/WHO SSDL Network

The IAEA/WHO Network of Secondary Standards Dosimetry Laboratories (SSDL Network) was established in 1976 as a joint project between the IAEA and the World Health Organization (WHO). At present, it includes 80 laboratories and six (6) SSDL national organizations in 67 Member States, of which over half are developing countries.



HSE
Occupational Health & Safety
and Environmental Protection Unit

THANK YOU

And don’t forget to wear your dosimeter !

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