

IRSN

INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

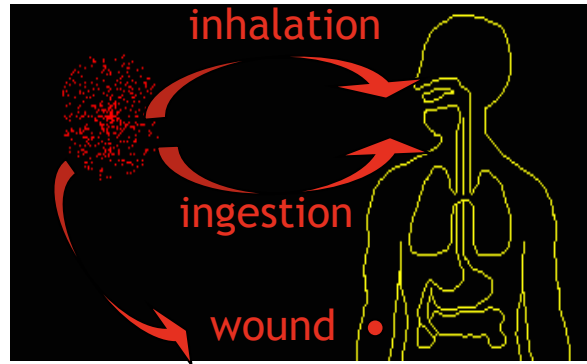
Development of mobile laboratories for Routine and Large Accident Monitoring of Internal Contamination

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Monitoring of people exposed to internal contamination

In vivo measurements
Radionuclide retention



In vitro measurements
Radionuclide excretion

X, γ emitters

^{137}Cs , ^{60}Co , ...

Direct Measurement of
radionuclides
(lung, thyroid, whole body)



α , β , γ emitters

U, Pu, ^{241}Am , ^{90}Sr

Bioassay Measurements after
chemical purification
(urines, faeces)



 In case of radiological crisis *in vivo* monitoring techniques have been identified as superior to bioassay analyses for the estimation of internal exposure

Advantage

- Generally, release contains radionuclides which emit high-energy gamma rays
- there could potentially be a large number of people who require monitoring and direct and rapid estimate of the internal contamination will be crucial
- The possibility of moving the measurements means pretty close to the accident

 With the financial support of the French Health Ministry the IRSN has decided in 2007 to renovate and complete the existing fleet with the following requirements:

1. Able to monitoring on-site up to 2500 people per day and capable to answer to any radiological emergencies involving internal contamination of gamma emitters ranging from PAF to actinides
2. Able to detect activity at a level corresponding to a committed effective dose of 1 mSv
3. Capable of fast intervention in France or Europe if required, and completely self-contained

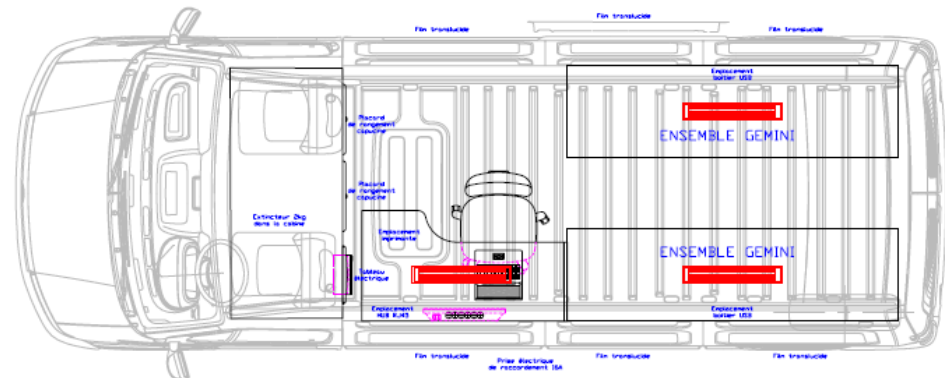
The Fleet of Intervention Mobile at IRSN

- **4 light emergency body counting mobile units:** to carry out a fast trial of contaminated / non contaminated people
- **4 heavy emergency body counting mobile units:** for a better management of the psychosocial phase of the crisis
- **2 expertise body counting mobile units:** to carry out a trial of contaminated individuals in case of complex contamination or expertises for nuclear workers.

The light emergency body counting mobile units : 4 minivan equipped with 4 *in vivo* “Gemini” seats



- Electrogen group (24 h autonomy)
- GSM and satellite communication



The “Gemini” *in vivo* monitoring system

■ GEMINI systems :

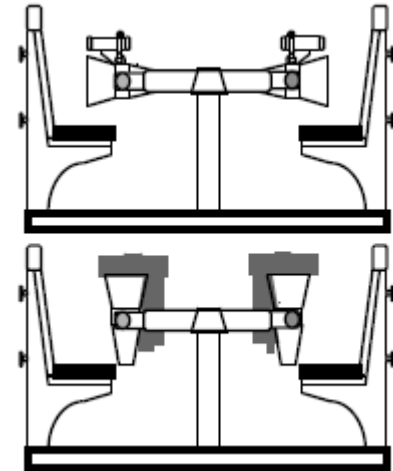
- 2 [NaI(Tl)] detectors placed in front of the thorax and thyroid
- collimator in lead around both detectors
- Energy range 100 - 2 000 keV
- Resolution at 662 keV \approx 50 keV (7,5 %)

■ AVANTAGES :

- Seat counting geometry
- Adapted to different types of measurements (adults, child, wounded peoples)

■ DRAWBACK :

- Sensible to high background (light shielding)
- Range of energy not suited to actinides measurements (Pu ; Am)
- Difficulty of multi element analysis (poor resolution)



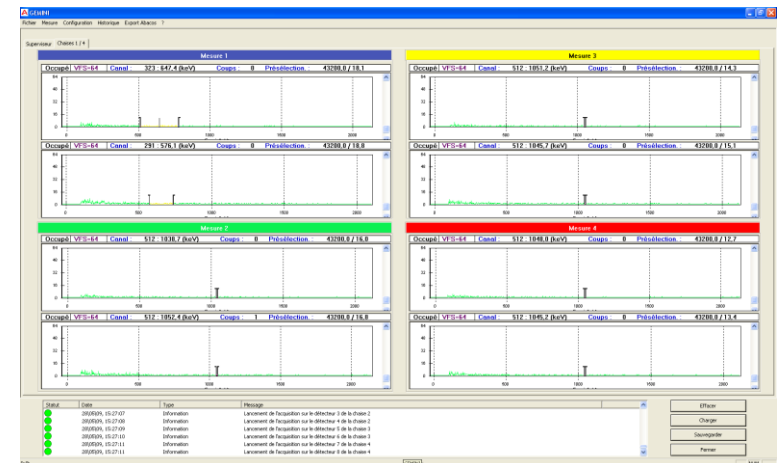
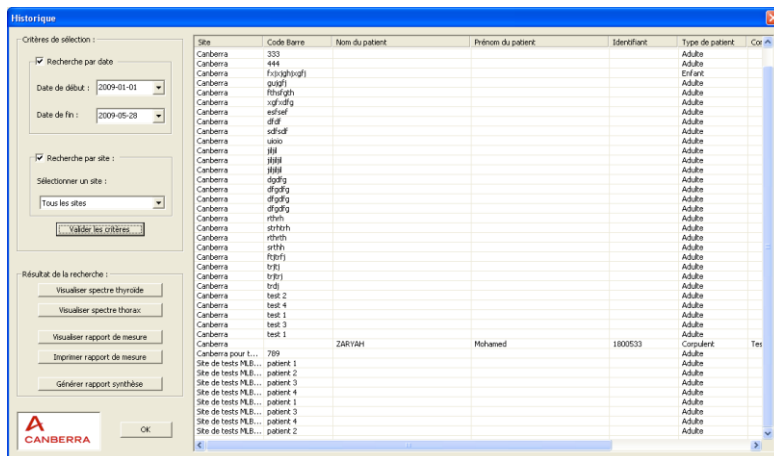
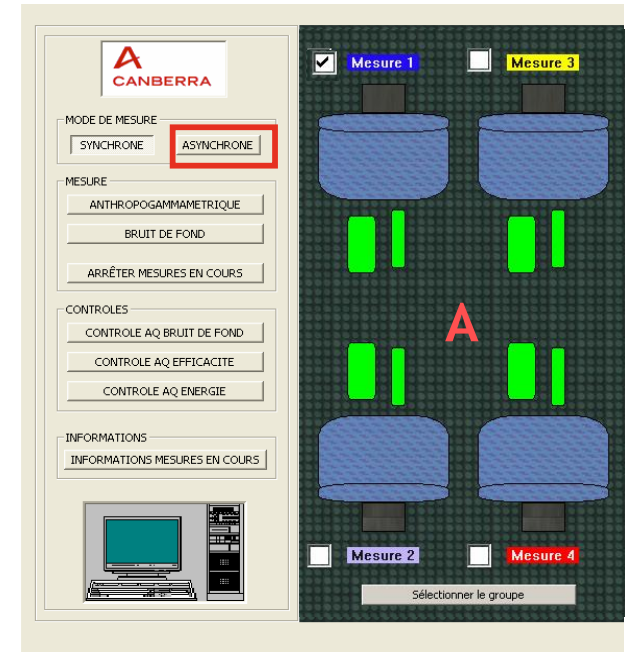
Specific monitoring Software for emergency mobile units

■ “GEMINI” SOFTWARE REQUIREMENTS:

- Tool specially developed for the use during crisis situation in all emergency vehicles
- Simple and easy to use for non expert people
- Visual and intuitive uses

■ FONCTIONNALITIES :

- Acquisition and analysis of up to 24 detectors in the same time
- Procedures for reporting activities and transfer to the Crisis center from the field



The heavy emergency body counting mobile units: 4 SHELTERS equipped with 10 “Gemini” seats



■ TECHNICAL SPECIFICATIONS:

Same Gemini measurement systems
and same software as the light vehicles



The heavy emergency body counting mobile units

Other specifications:

- Qualified for transportation by military truck and for air transportation (HERCULE C130 et TRANSALL C160)
- ⇒ To be transported and parked everywhere (France, Europe, etc.)

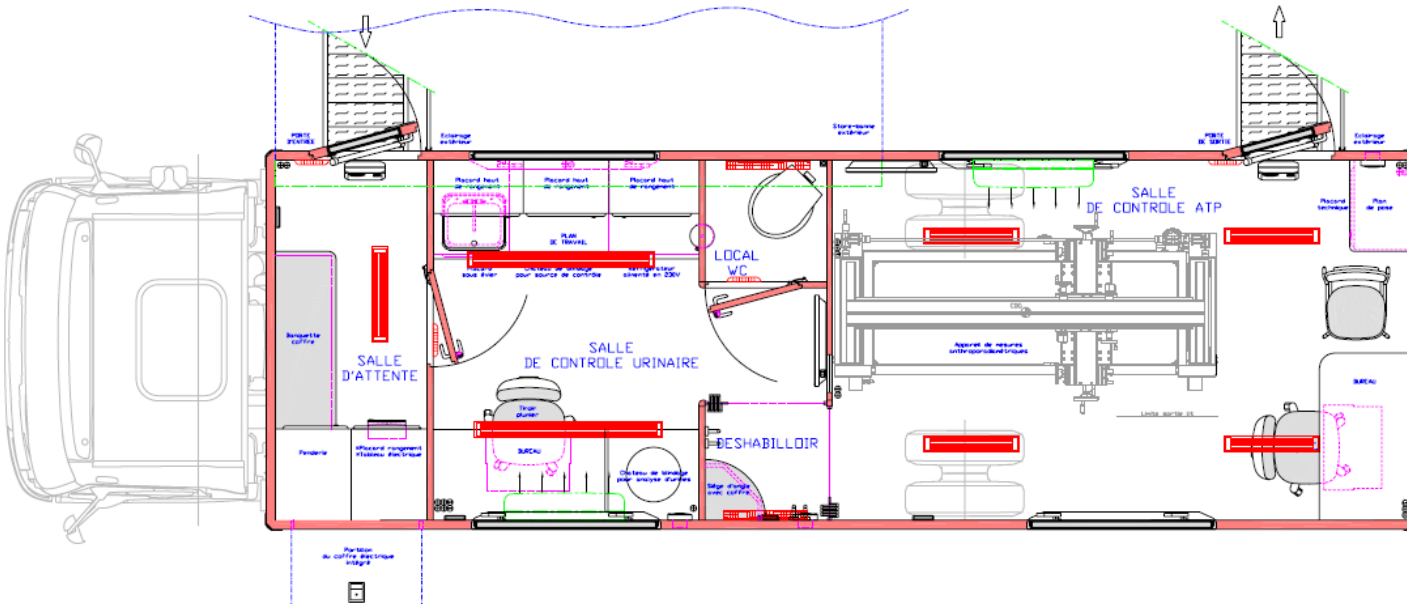


PHOTO ARMEE DE L'AIR



The expertise body counting mobile units : 2 TRUCKS

- 9.30 m long by 2.5 m wide, Weight: 13 tonnes
- Design as a fixed laboratory :
 - 3 main rooms (waiting, office and WBC)
 - Toilettes, bench for conditioning urine samples and urine sample measurement system



- Electrogen group (48 h autonomy)
- GSM and satellite communication

The *in vivo* monitoring system

■ 2 GERMANIUM DETECTORS (BEGe 5030) :

S: 5000 mm² , H: 30 mm ,
relative efficiency : 50 %

with cryoelectric cooling
system (CP5)

ENERGY RANGE: 10 - 2000
keV

RESOLUTION (R): 2.2 (1 332
keV)

■ AVANTAGES

Measurement of X and gamma
emitters in all geometries
Analysis of complex spectrum

■ LIMITATION

Nb of peoples to be controlled



- Both detectors are fixed on an arch moved up and down electrically
- Each detector can be independently adjusted in all directions by 3 cranks

- 5cm thick low background lead and 0.5 cm copper surrounding the detectors and the measurement bed

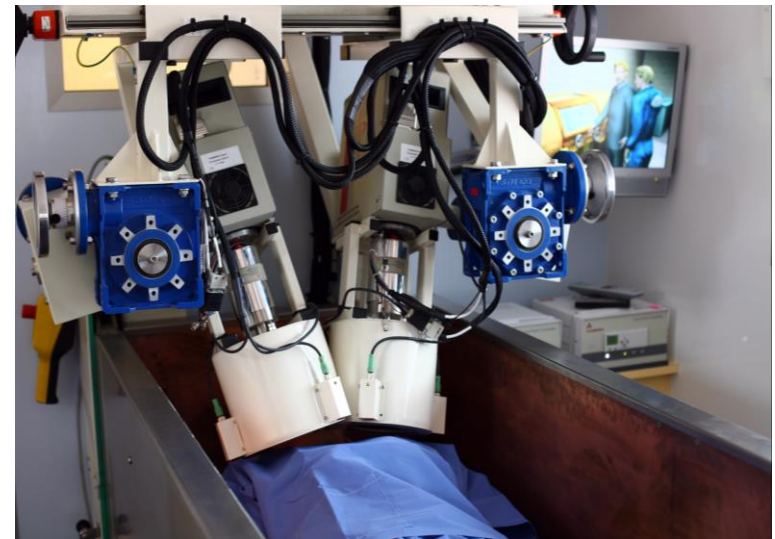
In vivo measurement geometries



Whole body geometry



Thyroid geometry



Lung geometry

Performances of the Mobile Units for *in vivo* monitoring

- Comparison of the Detection Limits (DLs) for typical radionuclides, corresponding to different counting geometries with the activities remaining 24 hours and 7 days after acute inhalation corresponding to a 1 mSv committed effective dose (ICRP 56; ICRP 67)

- Main criteria
 - DLs were calculated following ISO 2010 with:
 - ✓ Standard counting time for both emergency and expertise vehicles: respectively 10 min and 20 min
 - ✓ Reference man and children were considered

Comparisons of Detection Limits for typical radionuclides after acute inhalation at a level corresponding to a committed effective dose of 1 mSv for our mobile systems: expertise (DLex) and emergency (DLem).

<i>Radionuclides</i>	<i>Measurement geometry</i>	<i>Activities (Bq) measured 24 hours after intake corresponding to 1 mSv</i>	<i>Activities (Bq) measured 7 days after intake corresponding to 1 mSv</i>	<i>Eγ (keV)</i>	<i>DLex, (Bq)</i>	<i>DLem (Bq)</i>
¹³² Te	whole body	1,5.10 ⁵	1,6.10 ⁴	228,2	40	450
¹³¹ I	thyroid	1,1.10 ⁴	7.1.10 ³	364,5	5	190
¹³⁷ Cs	whole body	8,4 .10 ⁴	6.4.10 ⁴	661,6	90	390
⁶⁰ Co	whole body	3,6. 10 ⁴	1.2.10 ⁴	1332,5	80	320
²⁴¹ Am	lung	8,2	7.7	59,54	15	/
²³⁹ Pu	lung	8,2	7.7	17,5	4. 10 ³	/

Bioassay measurements

Conclusion

- A new fleet of mobile units specially designed for accident monitoring of internal contamination have been developed at the IRSN since 2007 and is now in operation
- They can be moved to the measurement sites anywhere in France or Europe (Shelters) within 24 hours and be operational in less than 2 hours
- They can carry out *in vivo* measurements for different types of contaminations and can be used on a wide range of subjects
- Thanks to the use of specific shielding it has been shown very good sensitivities even with emergency units since activities equivalent to a dose of < 1 mSv can be detected for a wide range of radionuclides even up to 7 days after intake by inhalation.

***Thank you for your attention
I will be happy to answer to your questions !***

