IRSN
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Retrospective Biodosimeter at IRSN

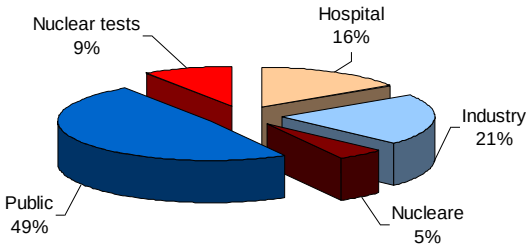
Fifteen Years of Practice

IRPA Glasgow Mai 2012

eric.gregoire@irsn.fr

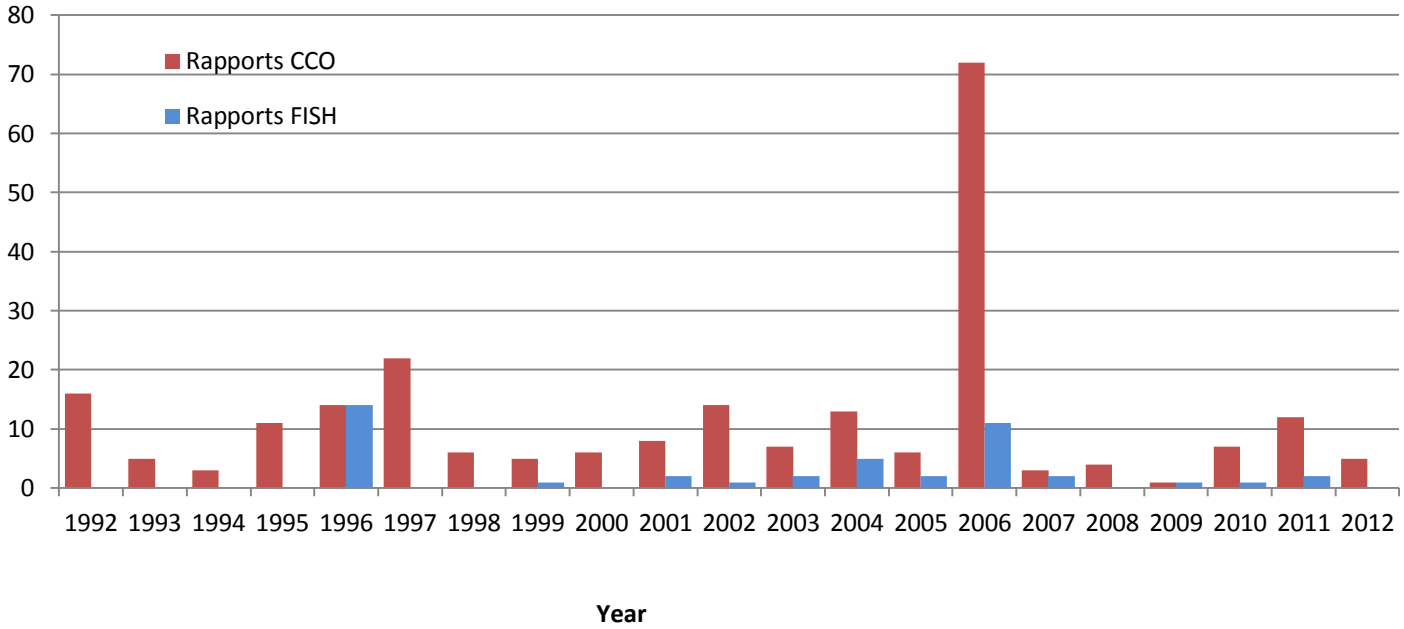
The Biological Dosimetry Laboratory in France
Expertise activity of LDB

Distribution of accidents among categories (1992-2010)



- ✓Created in 1992
- ✓287 expertises since 1992.
- ✓Appointed by specialist doctor or by IAEA

Number of Expertises per year



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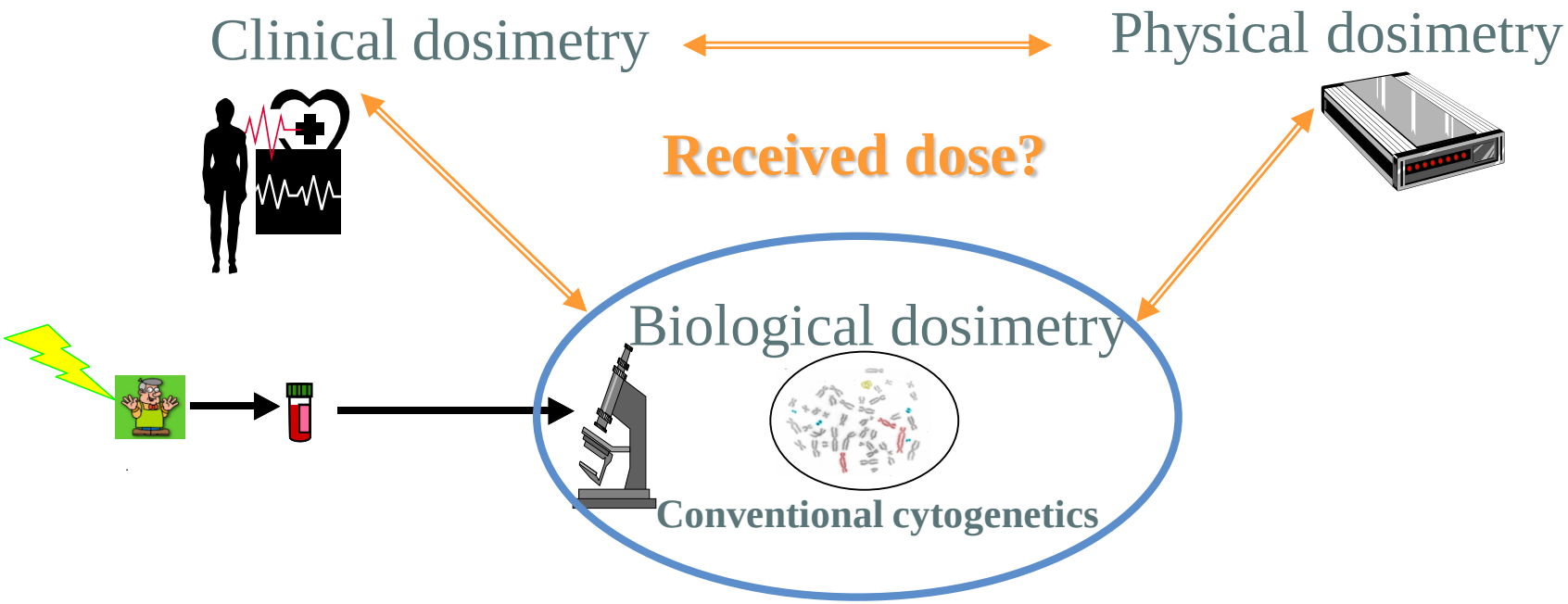
Dosimetry?

In case of accidental radiation exposure:

1. People exposed or not?
2. What is the dose?

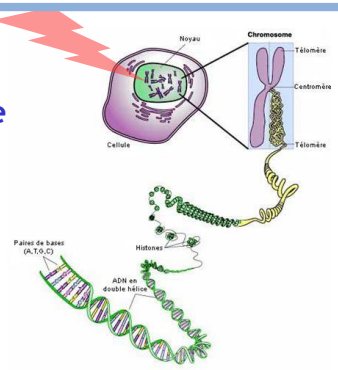


⇨ measurement of the radio-induced yield of dicentrics in the peripheral blood lymphocytes

Ionising Radiation Effects on DNA

Ionizing radiation

Peripheral Blood Lymphocyte



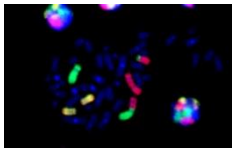
DNA FRAGMENTATION

Misrepair

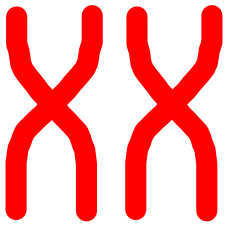
Reparation

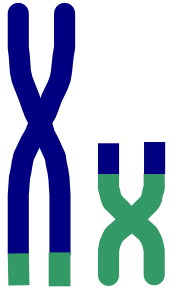
Repair

Misrepair



Dicentric
Recent exposure Marker





Two-way

Translocation
Old Exposure Marker

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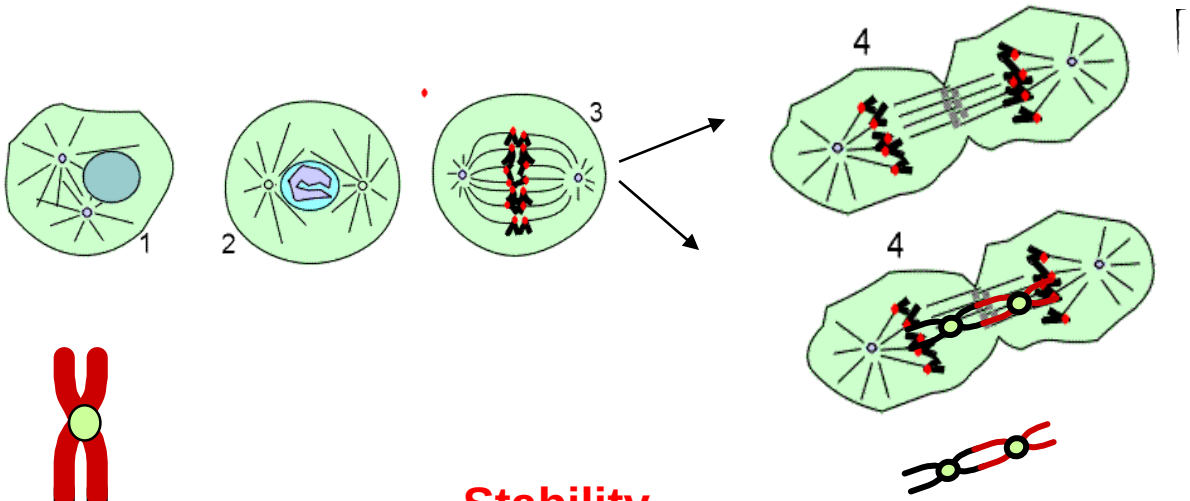
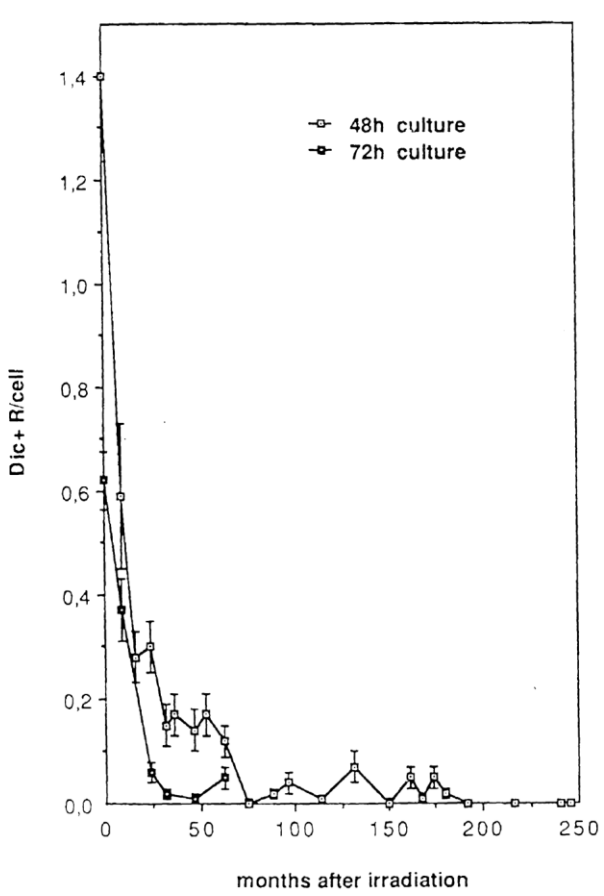
Dicentric Features



Stability

Disappearance of dicentrics with time (instables aberrations)



A more stable aberration?

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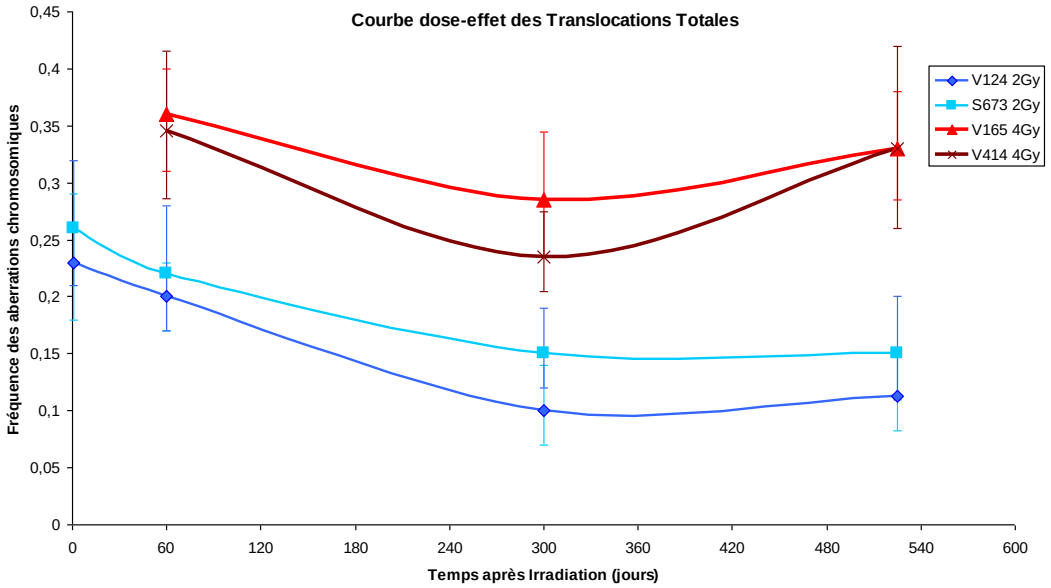
Translocations Stability in time

Follow up on monkeys irradiated *in toto*



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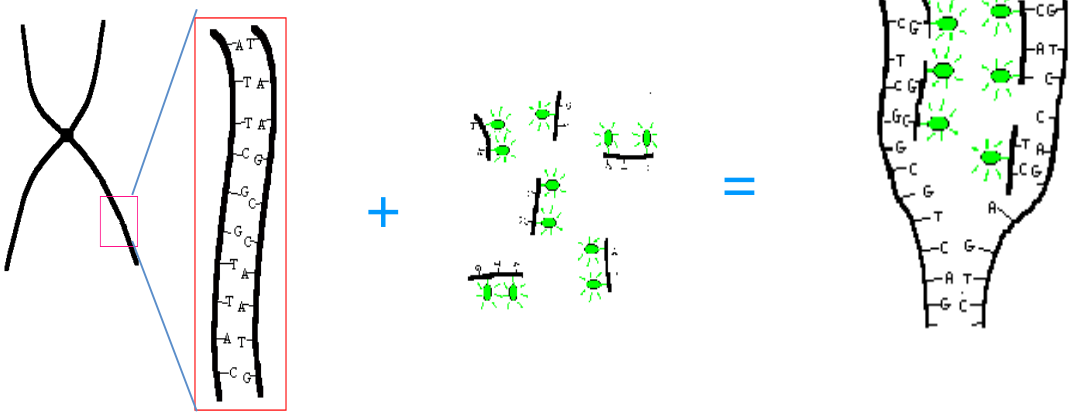
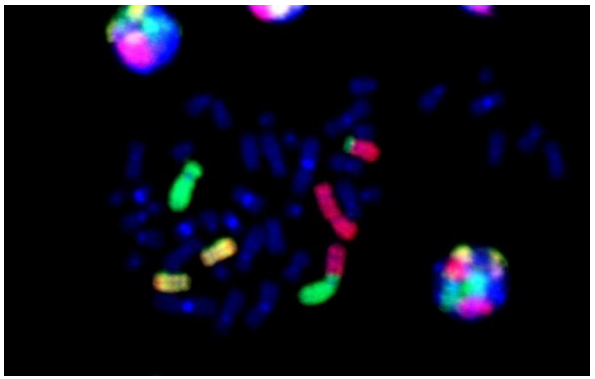
Translocation: Old Exposure Marker

Purpose

- Painting chromosomes
  - Probes are specific of a selected chromosome
  - Probes are coupled with a dye of different color for each chromosome





Painting of 3 chromosomes (2, 4, 12)

(IRSN/LDB)

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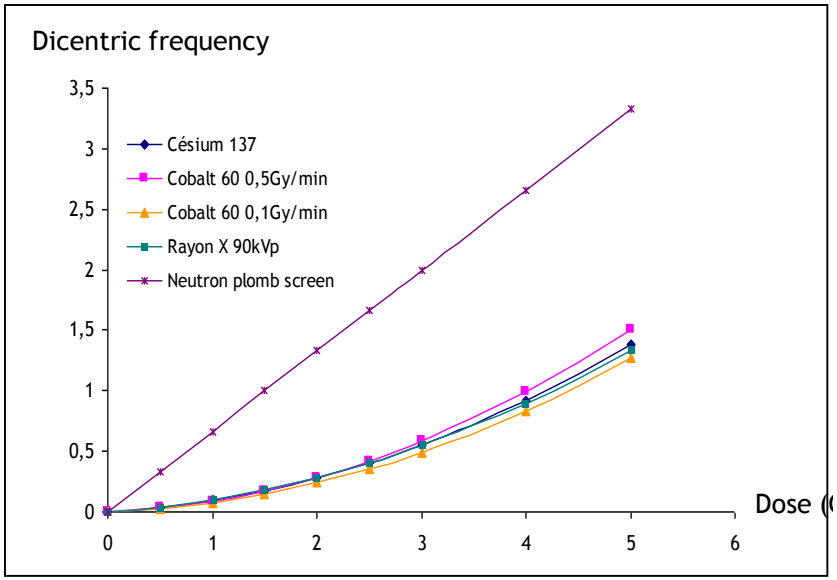
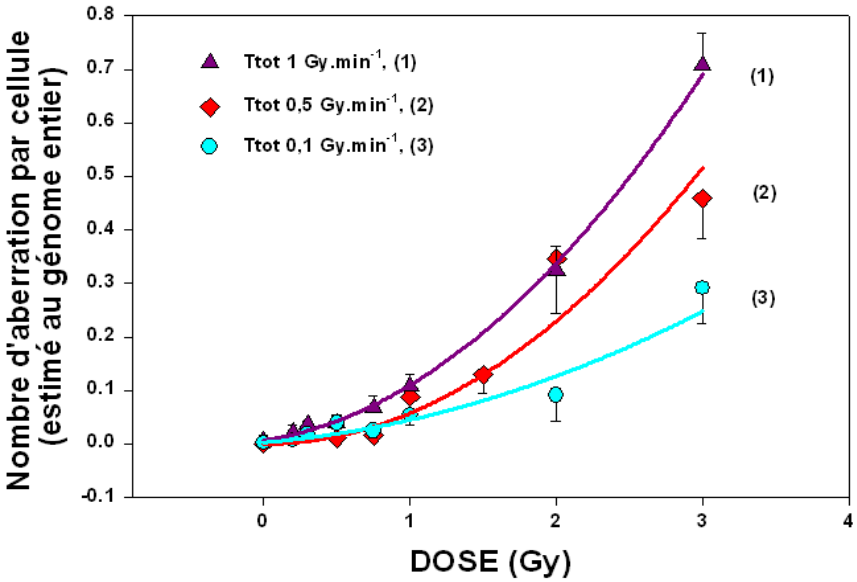
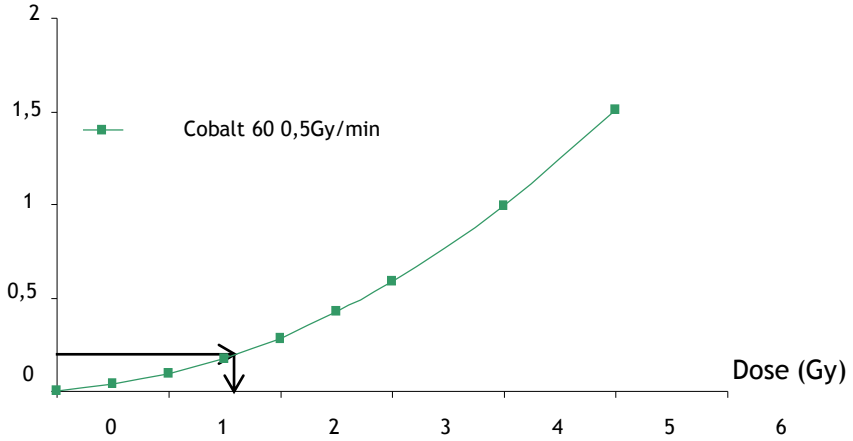
IRSN Dose-Effect Curves



Total translocations



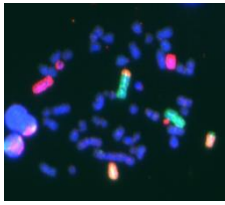
⇒ **Dose estimation**



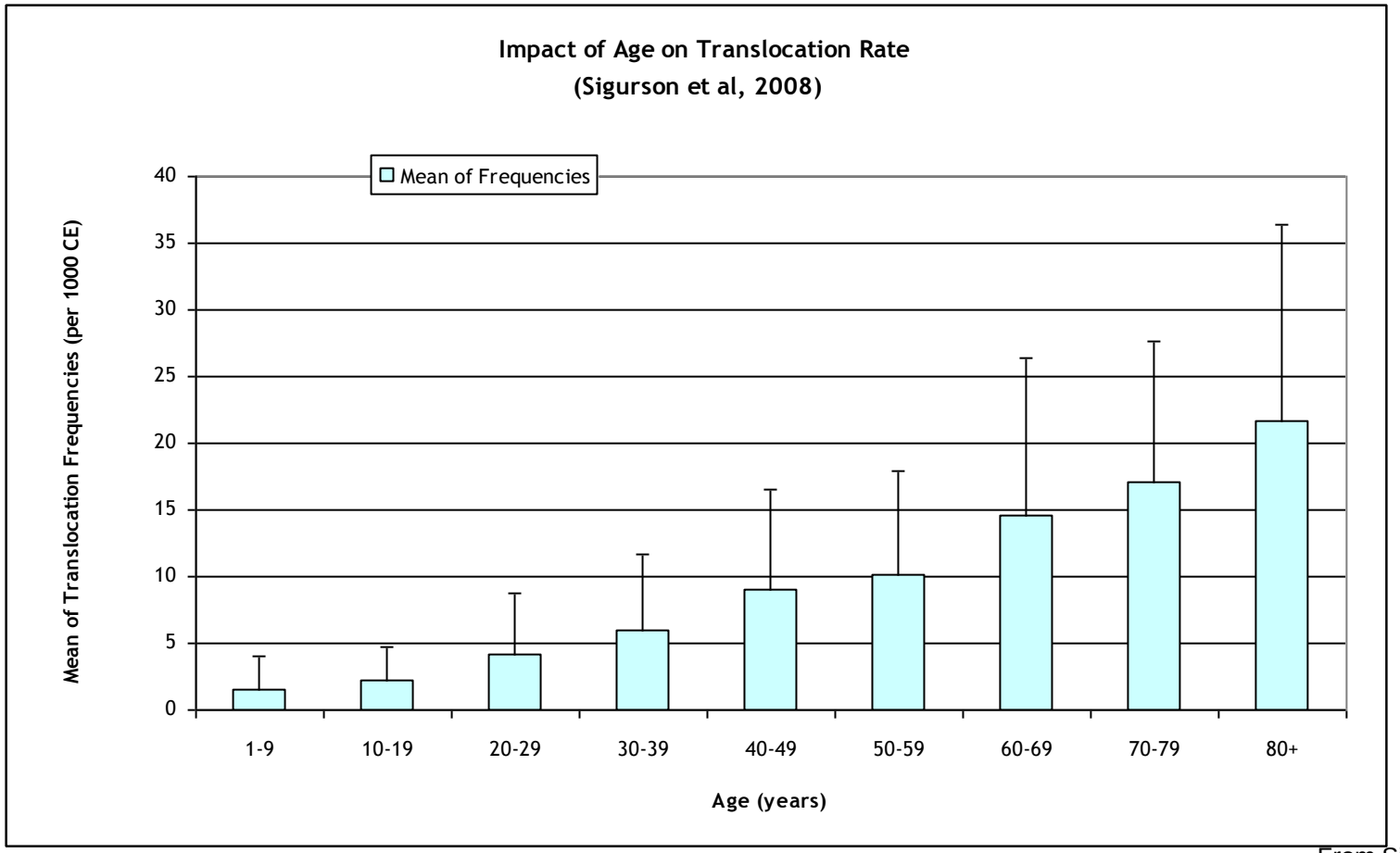
Dose assessment

eric.gregoire@irsn.fr

Translocation rate from non-radioexposed population



Study on 1933 subjects and 16 laboratories from 4 different geographic areas

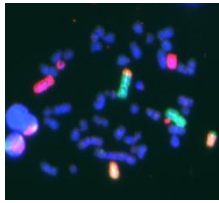


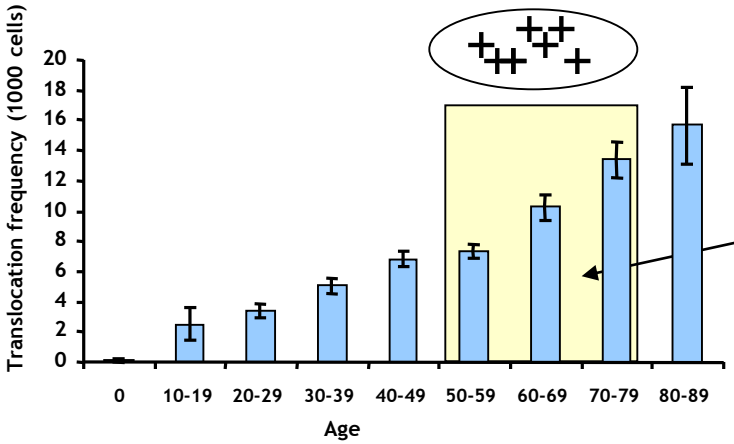
From Sigurdson et al., 2008

⇒ Translocations show an exposure from an environmental stress

eric.gregoire@irsn.fr

Translocation rate from non-radioexposed population

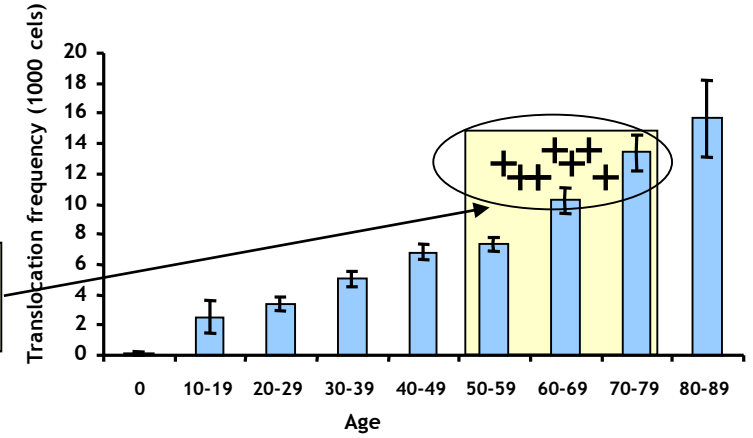




⇒ Translocation frequency is over the non-exposed population translocation background, so individuals present a significant environmental exposure,

Individuals present a non-significant environmental exposure.

Sample translocation frequency is IN the non-exposed population background.



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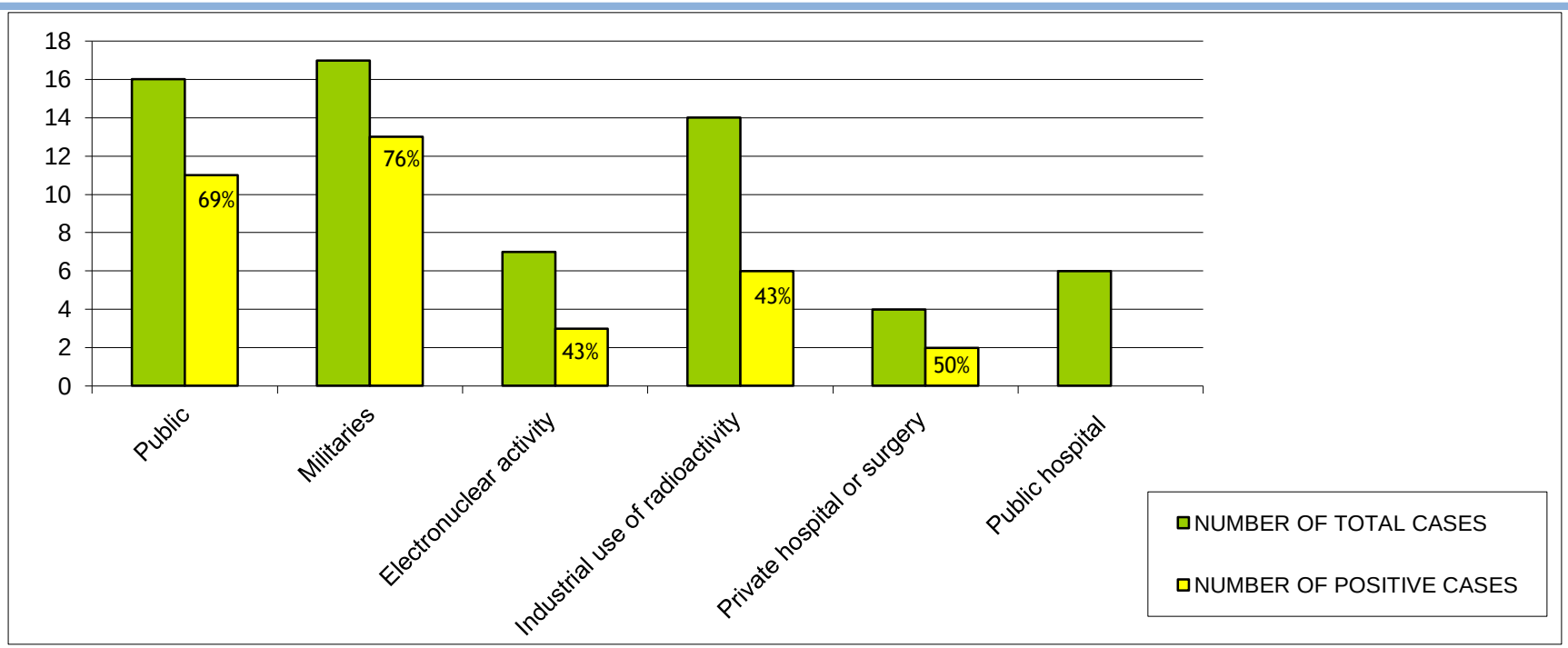
Cases analysed by FISH divided by categories

Repartition of the number of cases analysed with the FISH technique from 1995 to 2011.



- **Public and Militaries represent 50% of expertise cases**
- Public represents people not exposed for occupational reasons
- 80% of public positive cases are located outside France
- Militaries: For 43% of positive cases, there is no certitude in circumstances of irradiation
- Other categories: positive cases represent 1/2 total cases analysed

eric.gregoire@irsn.fr

ANALYSIS OF POSITIVE CASES

Cases with a long delay

Category	Exposure conditions	Exposure Time	Delay Exposure / Expertise	Cells scored	Total Translocations Dose	Dicentric Dose
PA	Embassy people living 90km away from Chernobyl	3 years	6 months	2000	0.4 [0.1-0.6]	0 [0-0.2]
P	research activity (Alopecia)	12 min	6 months	764	0.5 [0.2-0.9]	0 [0-0.2]
PA	Worked near industry used radionuclides	18 months	10 years	2931	0.6 [0.5-0.8]	0 [0-0.2]
I	Irradiated twice by a ^{192}Ir-source	1 time	10 years	2000	0.7 [0.5-0.9]	0[0-0.2]
M	Military working in the Polynesia during nuclear tests	2 years	30 years	1515	0.5 [0.2-0.7]	0 [0-0.2]
M				1545	0.5 [0.2-0.7]	0 [0-0.2]
M				1523	0.5 [0.2-0.7]	0.1 [0.01-0.3]

Are indicated the circumstances of the biological dose estimation, the exposure categories, the data of FISH scoring and the dose measured using both the FISH technique and the conventional cytogenetic one.

NA : non available ; Hp : private hospital ; P : Public : M : military ; I : industry; PA : polluted area next to industries; N : electronuclear industry

- **All cases complain of several pathologies and want to link with old overexposures.**
- **Various exposure time**
- **Delay exposure/expertise above 6 months and up to 30 years**
- **Total translocations may be reflect an IR exposure. Average translocation dose = 0.5Gy.**

➢Delay > 6 months : Dose CCO = 0

eric.gregoire@irsn.fr

Analysis of Positive Cases 4 Heavy Accidents

Category	Exposure conditions	Exposure Time	Delay Exposure / Expertise	Cells scored	Total Translocations Dose	Dicentric Dose
P	Several burns ^{192}Ir- source (Peru)	6h	3,5 months	1852	1.2 [1.0-1.4]	0.4 [0.2-0.6]
P P P	Georgian people carrying a Strontium source (Lia)	Several days	2 months	458 79 444	4.2 [3.8-4.5] 3.5 [2.7 -4.5] 1.9 [1.5-2.3]	3.1[2.9-3.3] 4.3[3.9-4.8] 1.3[1.1-1.5]
P P P P	Scrap dealers dismantling a radiotherapy system (^{60}Co) in Turkey	Several days	2 months	1101 845 127 637	2.6 [2.4-2.9] 1.9 [1.6-2.2] 1.8 [1.1-2.6] 2.3 [2.0-2.7]	1.7[1.3-2.0] 1.1[0.8-1.4] 1.2[0.9-1.4] 1.7[1.4-2.0]
M M M M	Cs-137 4Ci source left in a military camp in Georgia (Lilo)	1 year	2 months	1516 2333 2313 1793	0.8 [0.6-1.0] 0.4 [0.2-0.6] 0.9 [0.7-1.0] 1.4 [1.3-1.7]	0.5[0.3-0.7] 0.7 [0.5-0.9] 1.2 [1.0-1.4] 1.6 [1.3-1.9]

➢ **Most of Translocation Dose Estimation > Dicentric Dose Estimation** (red): maybe reflect an accumulated dose due to exposure duration. **Delay < 6 months : Dose FISH ≈ Dose CCO**

➢ **No overlap for all cases between translocation dose and dicentric dose except for 4 Georgians** (black).

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➢**Most of Translocation Dose Estimation > Dicentric Dose Estimation** (red): maybe reflect an accumulated dose due to exposure duration. **Delay < 6 months : Dose FISH ≈ Dose CCO**

➢**No overlap for all cases between translocation dose and dicentric dose except for 4 Georgians** (black).

➢ **Cases where Dicentric Dose > Translocation Dose** : Due to a very complex mixing heterogeneous and protracted irradiation, and by the fact that there were many translocations in cells with dicentrics that were not considered in dose estimation.

eric.gregoire@irsn.fr

Analysis of Positive Cases

Doses between 0.3 and 0.5 Gy

Category	Exposure conditions	Duration of Exposure	Delay between exposure and Expertise	Cells scored	Total Translocations Dose	Dicentric Dose
Hp	Radiological operator with no protection	10 years max	unknown	2410	0.4 [0.2-0.6]	0.2 [0.01-0.4]
I	Scanner maintenance with no protection.	Unknown	Several months	1522	0.4 [0.1-0.7]	0.1 [0.02-0.2]
N	Worked on source container (Cs-200 mCi).	30-45mn	6 months	861	0.6 [0.3-0.9]	0.2 [0.01-0.4]

NA : non available ; Hp : private hospital ; P : Public : M : military ; I : industry; PA : polluted area next to industries; N : electronuclear industry

✓There is a dicentric dose so these people were exposed to IR.

✓Therefore, a total translocation dose of 0.4 Gy is due to IR exposure.

⇒Doses between 0.3 Gy and 0.5 Gy could be detected by translocation dosimetry.

eric.gregoire@irsn.fr

Non Retrospective Dosimetry Cases

Short delay exposure / expertise (< 2 months)

Positive Cases with Dicentrics but Negative with Translocations

Case ID	Number of cell scored	Number of TwT	Number of Ttot	Dicentric dose
A	1518	2	3	0.2 [0.01-0.4]
B	577	0	1	0.2 [0.01-0.4]
C	1716	3	4	0.3 [0.1-0.4]
D	1974	1	4	0.4 [0.2-0.6]
E	2661	1	1	0.3 [0.1-0.5]

Ttot : total translocations ; TRc : reciprocal translocation i.e. two way translocations

Threshold of significativity: T tot = 5 / 1 000
TwT = 3 / 1 000

⇒ **Problem of dose detection by FISH technique below 0.3Gy**

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CONCLUSIONS

1. **When delay between exposure and estimation < 6 months:**
   a. Dicentric dose ≤ Translocation dose
   b. Translocations could measure a dose accumulation.
2. **In the individuals evaluated when delay between exposure and estimation > 6 months:**
   a. Dicentric dose = 0

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PERSPECTIVES

1. Improve translocation dose detection below 0.3Gy by considering other factors (age, lifestyle)
2. To decide which type of translocations is more suitable for dose assessment.

eric.gregoire@irsn.fr

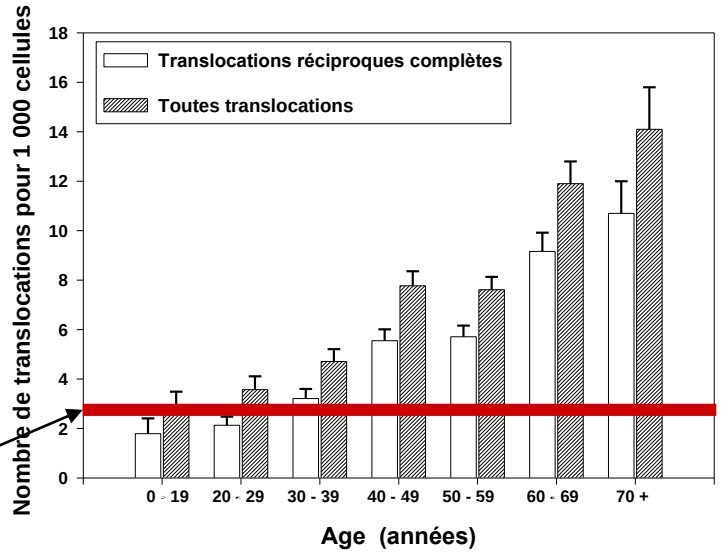
LDB Team

1. Joan-Francesc BARQUINERO* (PhD)
2. Sandrine ROCH-LEFEVRE (PhD)
3. Gaetan GRUEL (PhD)
4. Eric GREGOIRE (Scientist)
5. Pascale VOISIN (Technician)
6. Cécile MARTIN (Technician)

eric.gregoire@irsn.fr

Translocation specificity

- Estimation of translocation background in French population:
  - More than 15 persons of different gender and age
  - More than 38000 scored cells: 36 Ttot; 20 TwT
  - Threshold of significativity:
    T tot = 5 / 1 000
    TwT = 3 / 1 000
- European Background
  - Increasing yield with age
  - Influence of environment?

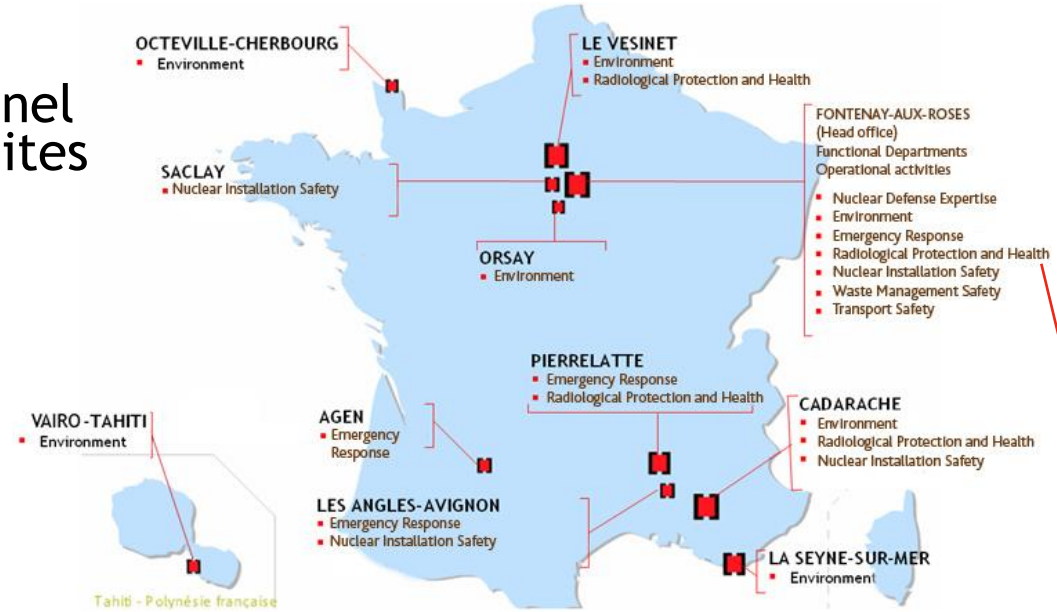


Average Background level of IRSN

⇒ So translocation dose represents exposure due to IR and environmental stress

The Biological Dosimetry Laboratory in France

1700 personnel at 11 sites



LDB: Laboratoire de Dosimétrie Biologique

eric.gregoire@irsn.fr