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INSTITUT
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Aircrew dosimetry The French solution: SIEVERT

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Système de management
de la qualité IRSN certifié

EURADOS AM2009

Workshop "Cosmic Radiation and Aircrew Exposure"

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REGULATION: European directive n°96-29 EURATOM

- European directive n° 96-29 EURATOM of 13 May 1996 substantially modified the norms governing health protection of the population and workers against the dangers of ionizing radiation.
- The inclusion of exposure to natural radiation is one of the innovations of this European directive.
- Concerning the protection of **aircrew**, article 42 states:

"Each Member State shall make arrangements for undertakings operating aircraft to take account of exposure to cosmic radiation of aircrew who are liable to be subject to exposure to more than 1 mSv per year."



REGULATION: Transposition into French law

- The European directive n° 96-29 EURATOM was transposed into French law by order n° 2001-270 of 28 March 2001.
- **French decree of December 2003 states:**
 - the individual exposure of any aircrew liable to be exposed to an effective dose higher than 1 mSv per year has to be assessed
 - the effective doses have to be evaluated for each flight using a **calculation method based on actual flight parameters** provided by airlines
 - the method of calculation takes into account the normal solar activity and **solar eruptions (GLEs)**.



The objective was to develop a tool for assisting airlines in the application of French regulation.



GENERAL OBJECTIVES

- Common approach among the different French stakeholders
- Different partners joined to create a common tool for French airlines
 - The French General Directorate of Civil Aviation (DGAC)
 - The Paris Observatory
 - The French Institute for Polar Research - PE Victor (IPEV)
 - The Institute for Radiation Protection and Nuclear Safety (IRSN)
 - Air France as operational adviser



OBJECTIVES OF THE PROJECT

- ✓ To develop an **operational, automatic and convenient** system for airlines including security and traceability
- ✓ To develop a tool able to:
 - calculate route doses using actual **flight parameters**
 - take into account solar eruptions (**GLE**)
- ✓ To propose a solution **accepted by all the stakeholders**
- ✓ To provide to the **public** an information and a dose assessment

THE SIEVERT SYSTEM

SIEVERT (French acronym: *Système d'Information et d'Evaluation par Vol de l'Exposition au Rayonnement cosmique dans les Transports aériens*)

= Computerized system for flight assessment of exposure to cosmic radiation in air transport.

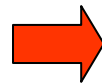
The selected solution consists of a **computerised service** which calculates doses and is accessible on a web server. This solution appears to be more reliable, less costly and less restrictive than using individual dosimeters or measuring instruments installed on board aircraft.

SIEVERT provides two services:

- a **tool for calculating doses** of cosmic radiation received during flights according to the routes taken and made available to companies on a server restricted to professionals;
- a **website for information** on exposure to cosmic radiation, used to estimate the dose received during a flight (www.sievert-system.org).

SIEVERT: PRINCIPLE

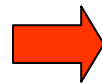
Airspace is divided into zones of altitude, longitude and latitude, forming a map with 265,000 meshes



Latitude: 2°
Longitude: 10°
Altitude: 1000 ft



An effective dose rate value ($\text{mSv}\cdot\text{h}^{-1}$) is estimated in each mesh

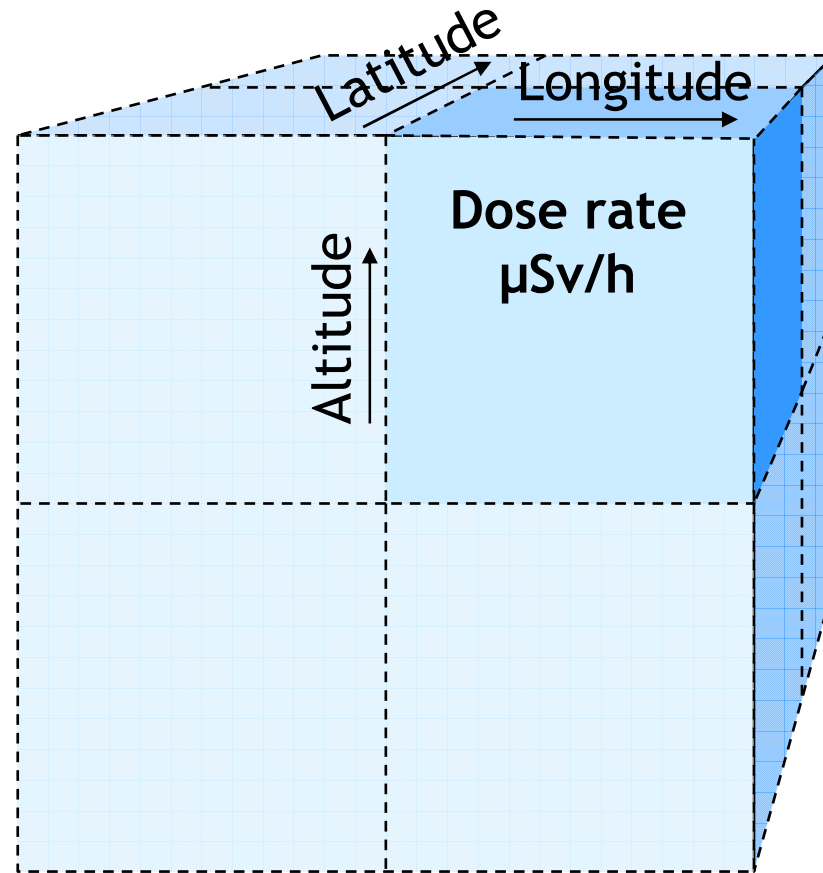


Effective dose rate map

DOSE CALCULATION

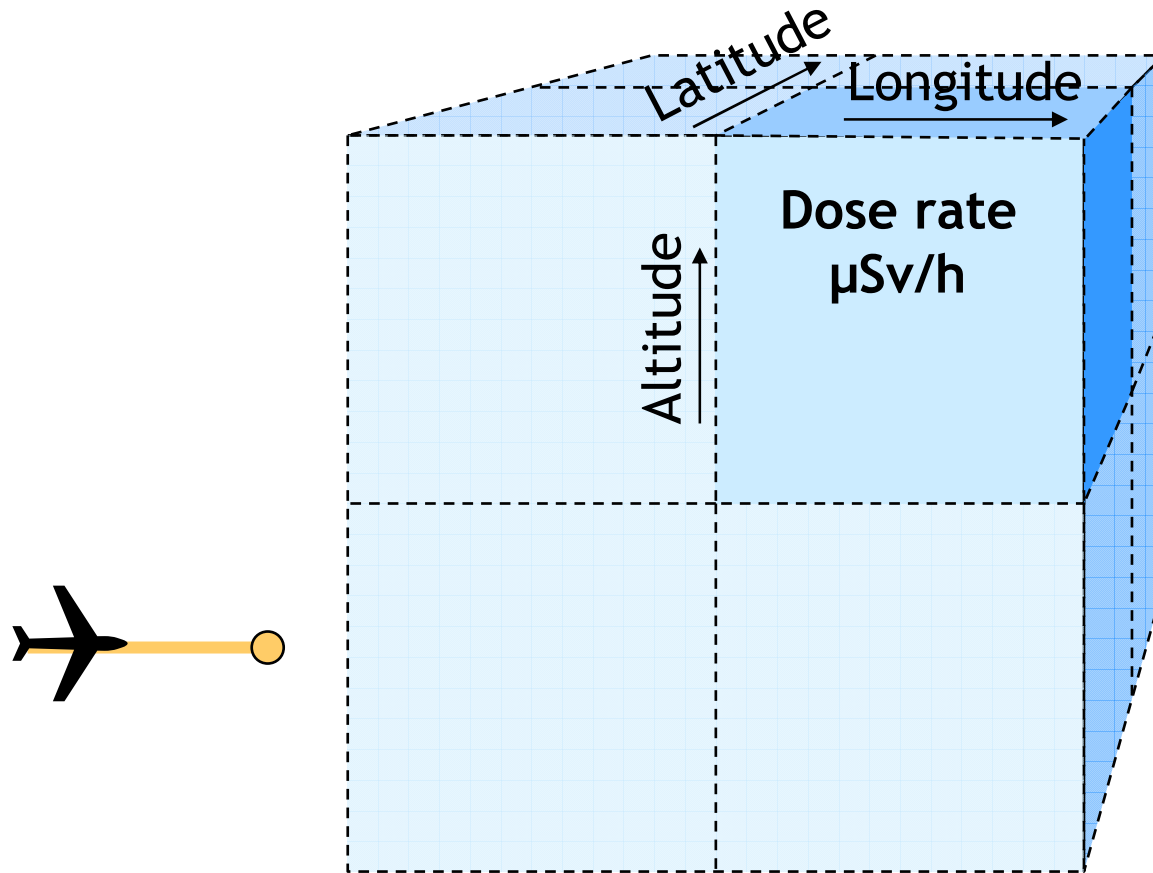
SIEVERT evaluates the time spent by the aircraft in each cell according to flight parameters and deduces the dose received by a simple multiplication.

Lat.: 2°
Long.: 10°
Alt.: 1000 ft



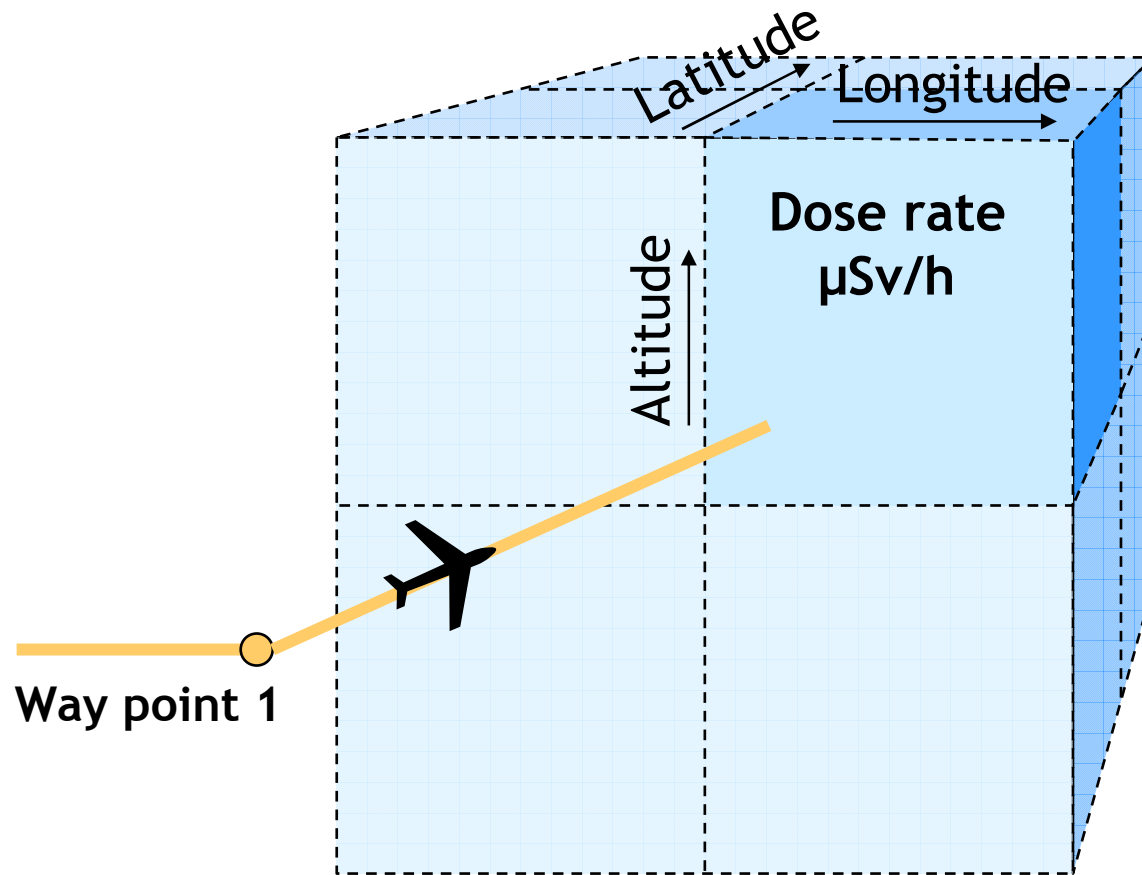
DOSE CALCULATION

SIEVERT evaluates the time spent by the aircraft in each cell according to flight parameters and deduces the dose received by a simple multiplication.



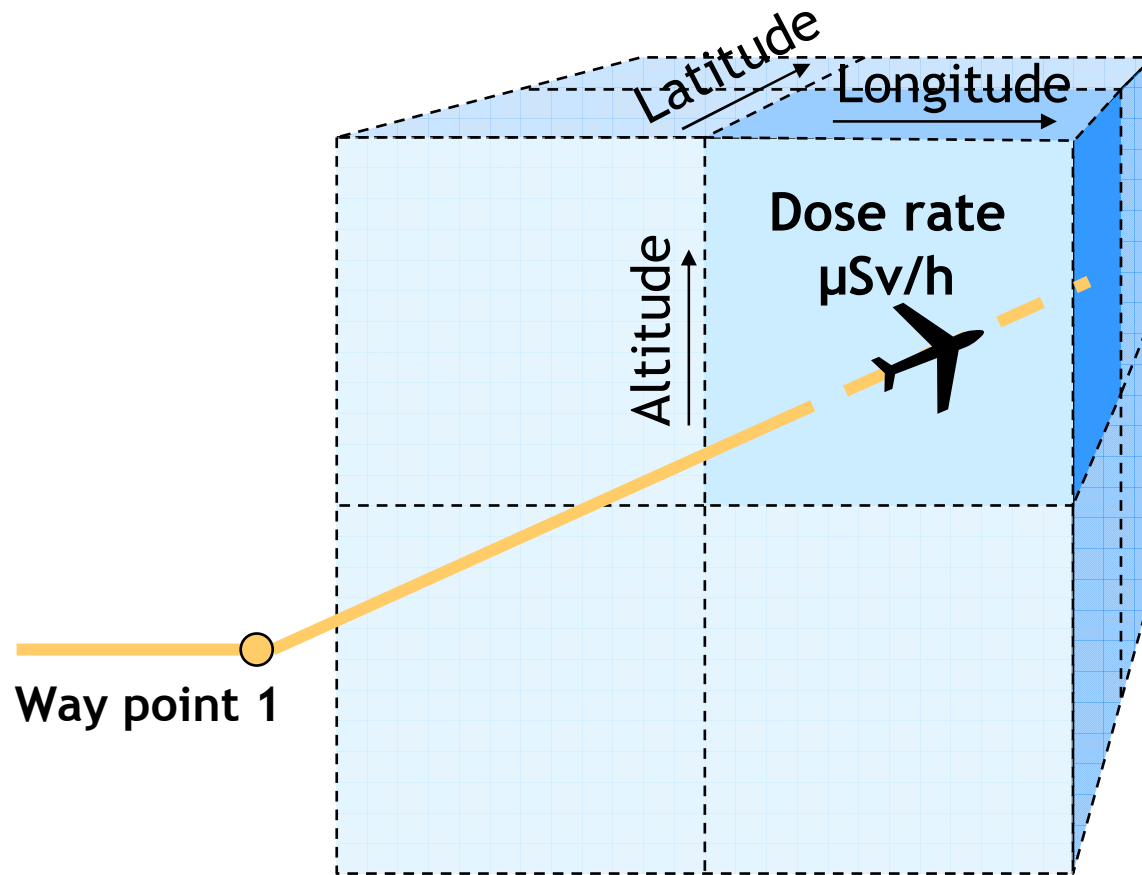
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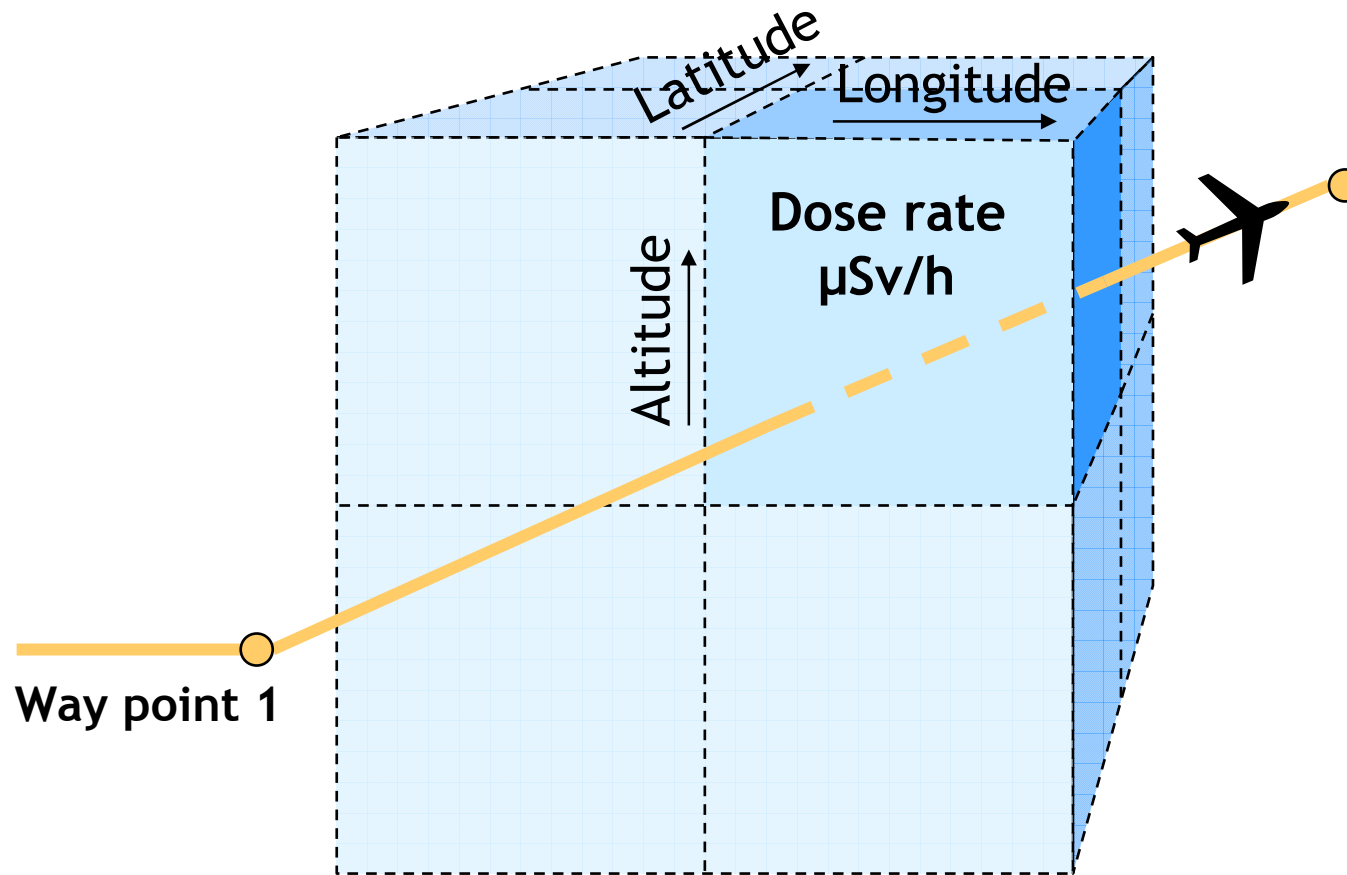
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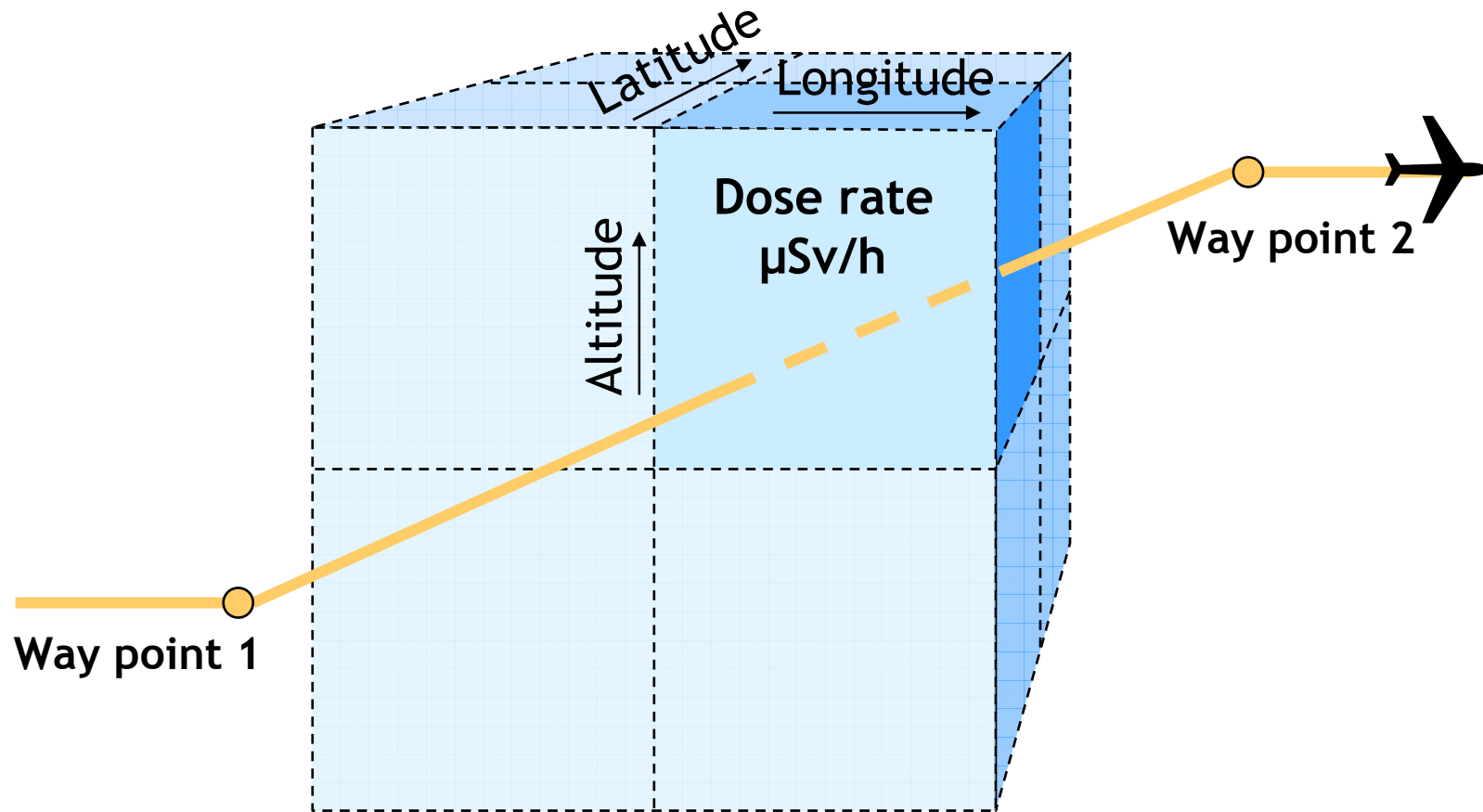
DOSE CALCULATION

SIEVERT evaluates the time spent by the aircraft in each cell according to flight parameters and deduces the dose received by a simple multiplication.



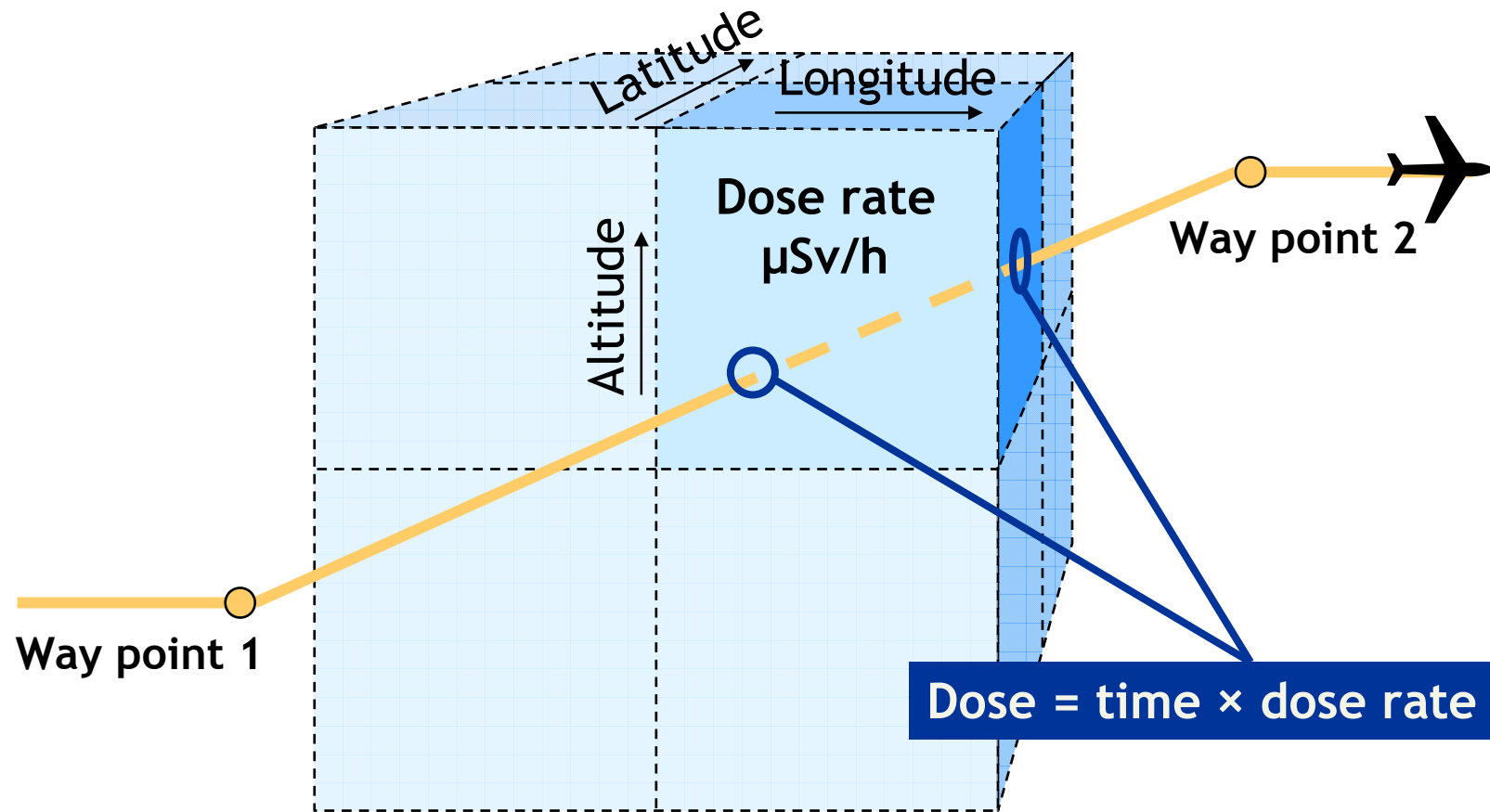
DOSE CALCULATION

SIEVERT evaluates the time spent by the aircraft in each cell according to flight parameters and deduces the dose received by a simple multiplication.



DOSE CALCULATION

SIEVERT evaluates the time spent by the aircraft in each cell according to flight parameters and deduces the dose received by a simple multiplication.



EFFECTIVE DOSE RATE MAP



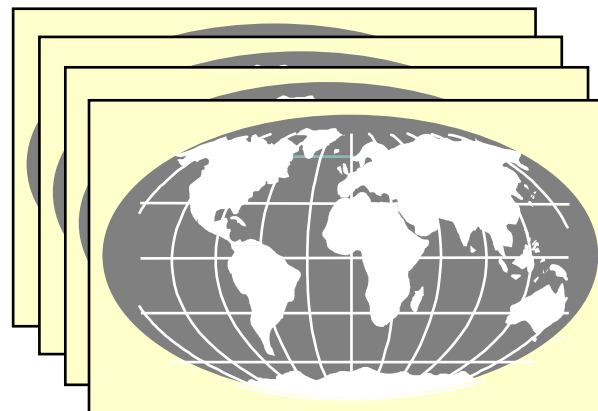
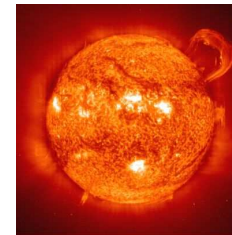
GALACTIC PART (GCR)

EPCARD model¹ (GSF)

Calculates the dose at any point in space up to an altitude of 80,000 feet
Monthly calculated

SOLAR ERUPTIONS (GLE)

Specific model (SIGLE)²



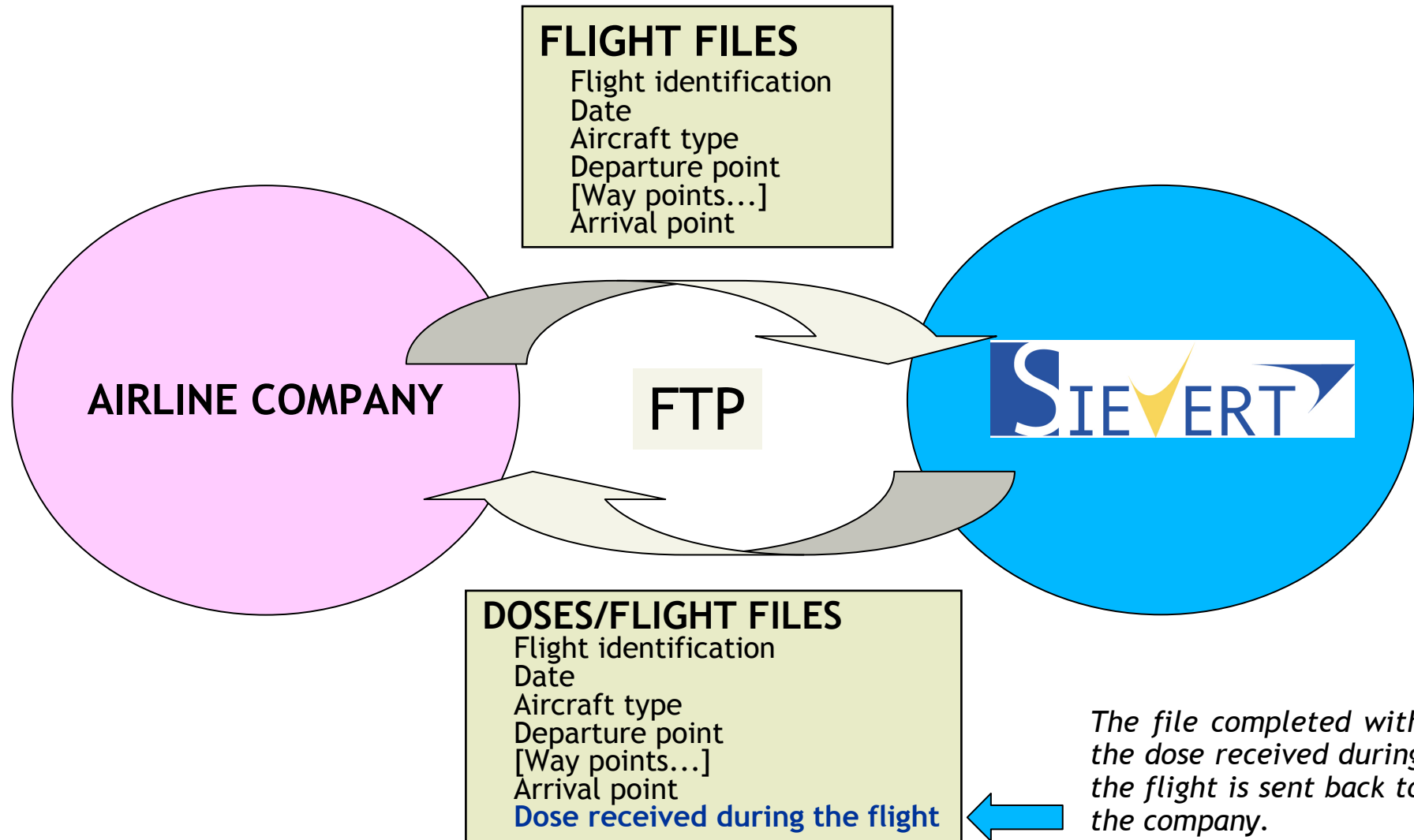
Every month, the effective dose map is validated by IRSN

Effective dose rate map
(Monthly or in case of GLE)

¹ Schraube, 1999

² Lantos, 2004


THE OPERATING PROCEDURE (1)

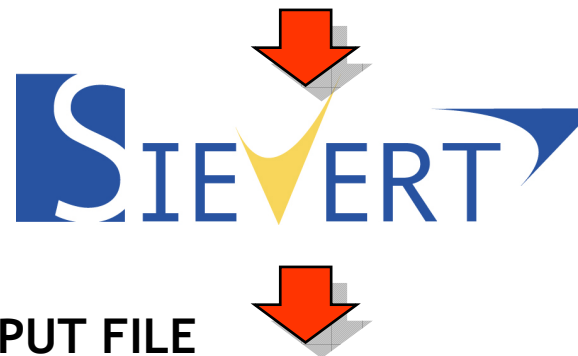


FLIGHT FILES FORMAT

FLIGHT FILES = INPUT FILE

```
00001;C;A;V;LFPG;LOWW;01/12/2006;06:15;01/12/2006;07:58;20612010113800;  
00002;C;A;V;LFPG;LIRF;01/12/2006;08:50;01/12/2006;10:34;20612010150400;  
00003;C;A;V;LIPZ;LFPG;01/12/2006;16:30;01/12/2006;17:55;20612010172700;  
00004;C;A;V;LOWW;LFPG;01/12/2006;14:30;01/12/2006;16:05;20612010173900;  
00005;C;A;V;LOWW;LFPG;01/12/2006;23:10;02/12/2006;00:46;20612010203900;  
00006;C;A;V;LFPG;LIRF;01/12/2006;18:00;01/12/2006;19:44;20612010230400;  
00007;C;A;V;LIRF;LFPG;02/12/2006;12:45;02/12/2006;14:26;20612020120500;
```


ICAO codes



DOSES/FLIGHT FILES = OUTPUT FILE

```
00001;C;A;V;LFPG;LOWW;01/12/2006;06:15;01/12/2006;07:58;20612010113800;0.0070;N;13/02/2007;  
00002;C;A;V;LFPG;LIRF;01/12/2006;08:50;01/12/2006;10:34;20612010150400;0.0060;N;13/02/2007;  
00003;C;A;V;LIPZ;LFPG;01/12/2006;16:30;01/12/2006;17:55;20612010172700;0.0061;N;13/02/2007;  
00004;C;A;V;LOWW;LFPG;01/12/2006;14:30;01/12/2006;16:05;20612010173900;0.0080;N;13/02/2007;  
00005;C;A;V;LOWW;LFPG;01/12/2006;23:10;02/12/2006;00:46;20612010203900;0.0079;N;13/02/2007;  
00006;C;A;V;LFPG;LIRF;01/12/2006;18:00;01/12/2006;19:44;20612010230400;0.0063;N;13/02/2007;  
00007;C;A;V;LIRF;LFPG;02/12/2006;12:45;02/12/2006;14:26;20612020120500;0.0056;N;13/02/2007;
```


Doses (mSv)

REAL PROFILES / STANDARD PROFILES

REAL PROFILES: way points

The more detailed the information concerning the route, the greater is the accuracy of the dose value. It is asked to airlines to describe a flight using waypoints.

Waypoint

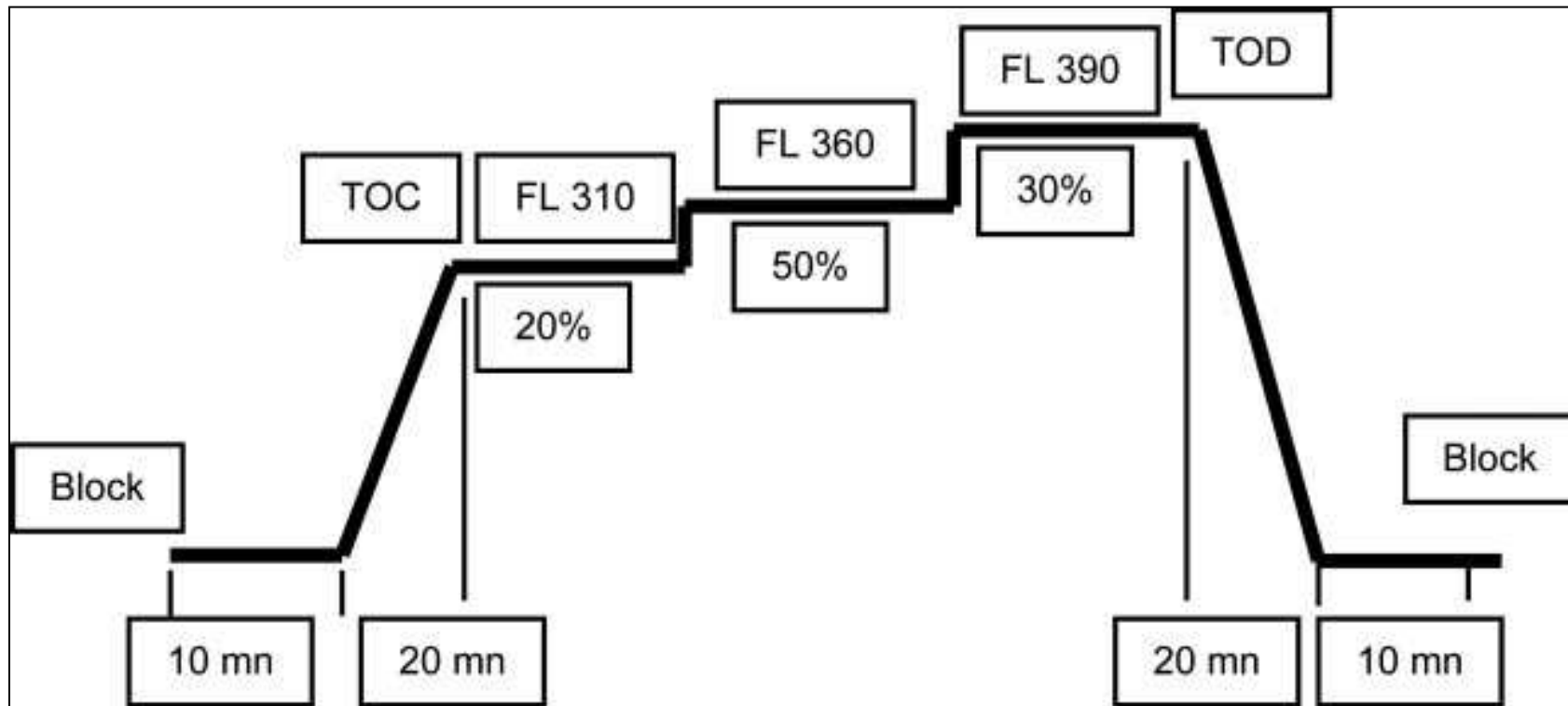


```
00195 ; AER ; 000 ; 00 : 00 ; 490036N ; 0023254E ;  
00195 ; TOC ; 270 ; 00 : 17 ; 474130N ; 0020200E ;  
00195 ; INT ; 290 ; 01 : 20 ; 403842N ; 0031454W ;  
00195 ; INT ; 310 ; 02 : 32 ; 325954N ; 0100854W ;  
00195 ; INT ; 320 ; 03 : 45 ; 250000N ; 0162130W ;  
00195 ; INT ; 340 ; 04 : 56 ; 161712N ; 0214012W ;  
00195 ; INT ; 340 ; 06 : 00 ; 082012N ; 0260306W ;  
00195 ; INT ; 340 ; 07 : 15 ; 005612S ; 0305512W ;  
00195 ; INT ; 360 ; 08 : 12 ; 080812S ; 0345536W ;  
00195 ; INT ; 360 ; 09 : 37 ; 165900S ; 0414606W ;  
00195 ; TOD ; 360 ; 10 : 30 ; 214842S ; 0463218W ;  
00195 ; AER ; 190 ; 10 : 53 ; 232606S ; 0462824W ;  
00196 ; AER ; 000 ; 00 : 00 ; 232606S ; 0462824W ;  
00196 ; TOC ; 240 ; 00 : 19 ; 214130S ; 0451330W ;  
00196 ; INT ; 310 ; 01 : 29 ; 120624S ; 0412554W ;  
00196 ; INT ; 330 ; 02 : 28 ; 034618S ; 0383254W ;
```

STANDARD PROFILES:

If the information is minimal, like information available on flight ticket, the dose value is assessed using a standard route profile

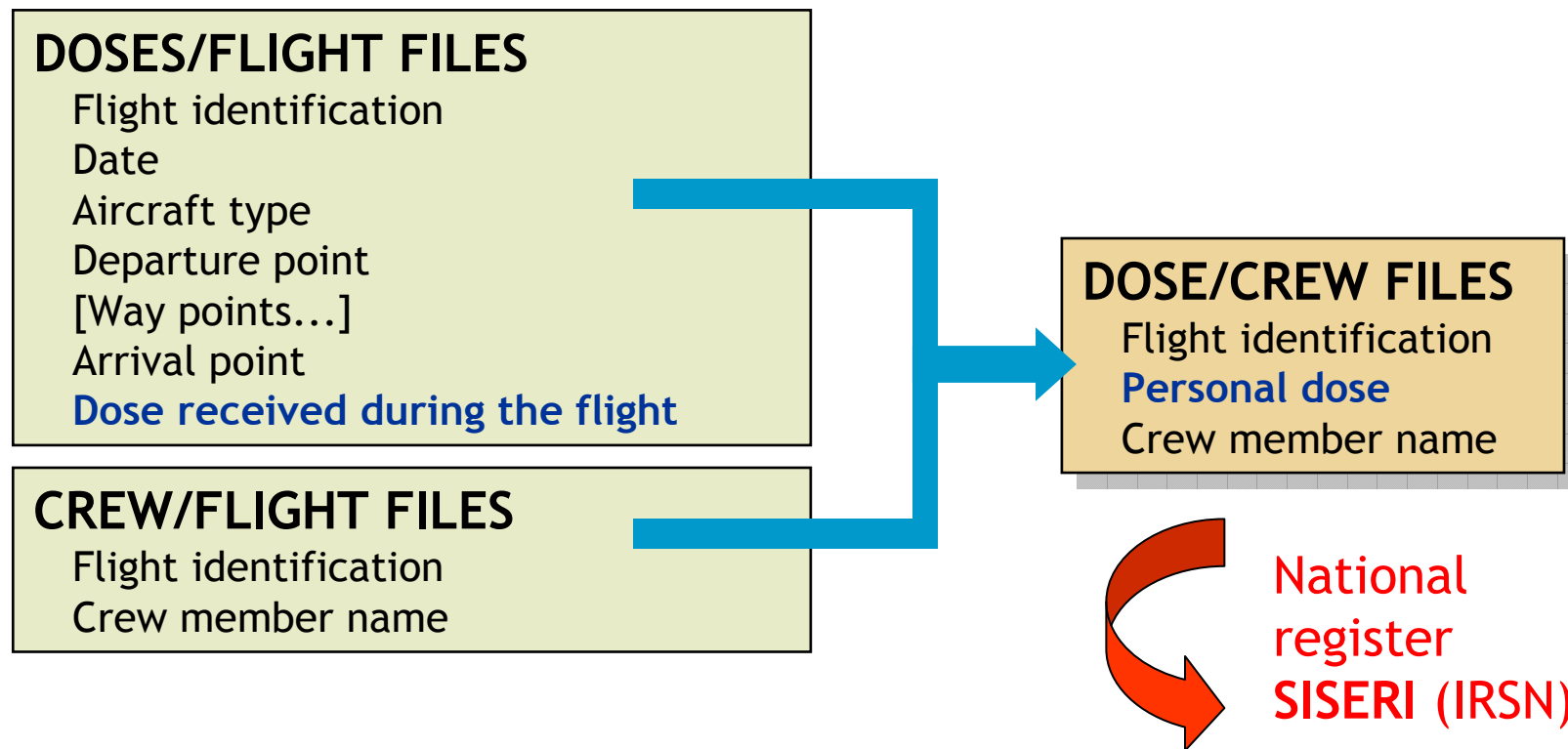
EXAMPLE OF STANDARD PROFILE



Criteria used for the definition of a standard flight profile for long-haul subsonic flight. TOC: top of climb, TOD: top of descent, FL: flight level (ft per 100), block: parking.

THE OPERATING PROCEDURE (2)

At this stage, the dosimetric data are not nominative. It is then up to airlines to produce a total of doses received during flights made by each member of flight personnel.



THE WEB SITE: www.sievert-system.org

Calculate the dose received ✓ What is cosmic radiation? ✓ Exposure to cosmic radiation in the plane ✓ The health effects of radiations ✓ Measuring radiation and assessing its effects ✓ The experts tell you more ✓ Glossary ✓ Search OK

✓ Site map ✓ Frequently asked questions

DEPARTURE :

Country : FRANCE

City : PARIS

Date : 28 01 2009

Time : 09 50

ARRIVAL :

Country : GERMANY

City : HANNOVER

Date : 28 01 2009

Time : 11 20

Type of aircraft : Subsonic

Calculate the cosmic radiation dose received during this flight vol

SIEVERT System implemented and integrated by LOGATIQUE

"Subject to local regulation modifications, the flight dates and times include time difference and, if necessary daylight saving time. Check the flight time."

Dose received during the flight = 0.0041 mSv
Flying time = 01:30 (HH:MM)

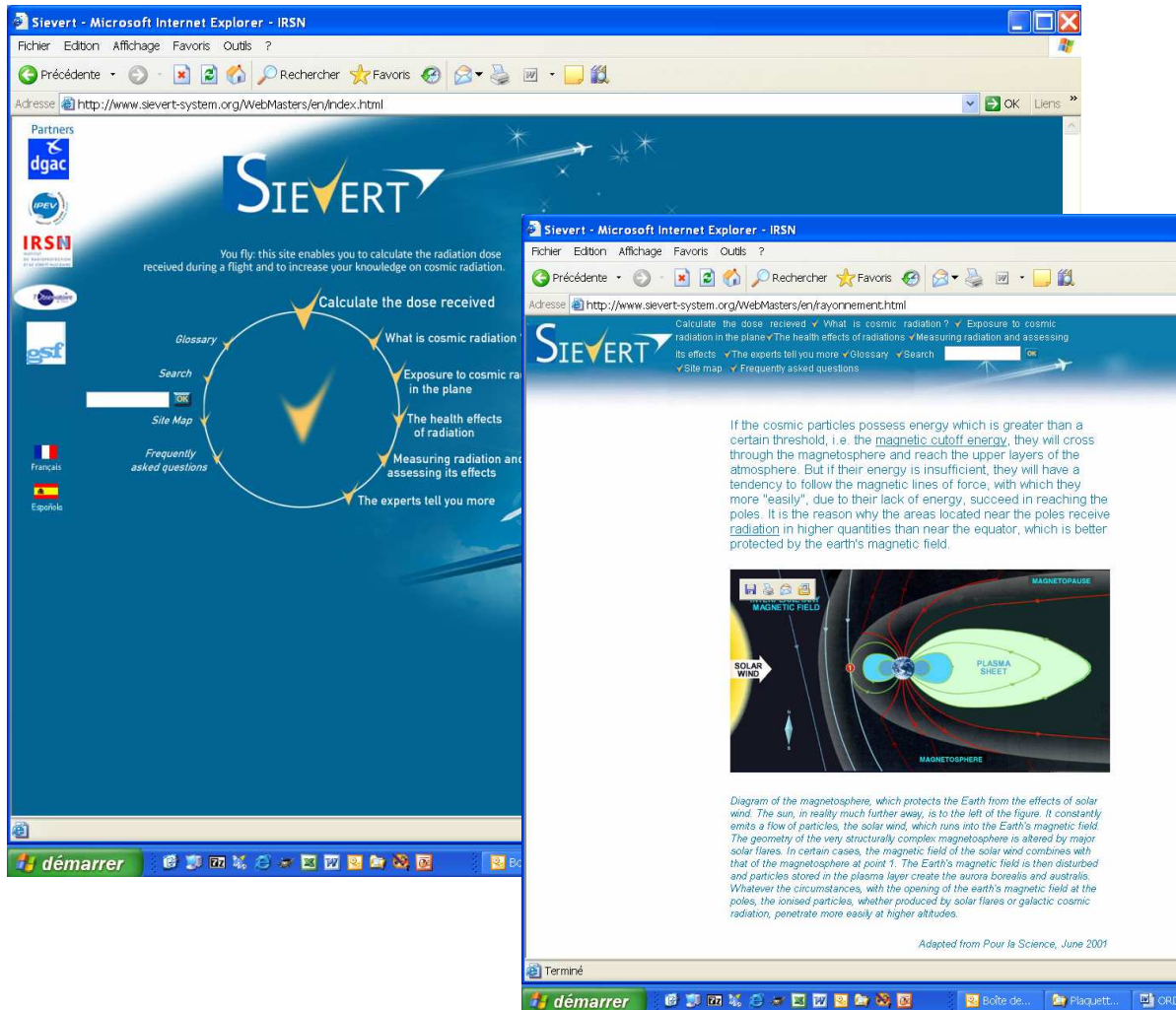
Departure city	Arrival city	Departure date	Arrival date	mSv	Estimated
PARIS	HANNOVER	28/01/2009 09:50	28/01/2009 11:20	0,00410	Oui
Total				0,00410	

The SIEVERT website provides free access to calculate the dose for a standard flight.

The assessment is carried out using information contained on the flight ticket.



THE WEB SITE: www.sievert-system.org



General information about the cosmic rays, the regulation and the risk associated to radiation is available on the SIEVERT website.

STATISTICS

- ✓ Around 20 airlines use SIEVERT
- ✓ 40,000 flights treated per month
- ✓ 1700 connexions/month on the website

CONCLUSION

- SIEVERT, a system of an operational nature, is the answer to a request from the airline companies for radiation protection for aircrew members. The routine dosimetry is made by calculations.
- Moreover, it makes it possible to assess the dose received during a flight for anybody who wants the information via the website.

