



INSTITUTE FOR ADVANCED STUDIES

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Jan/2016

Research group for studies of the effects of ionizing radiation on devices and materials for aerospace use

Main lines of activity:

- **Effects of cosmic radiation** on electronic devices and crew;
- **Computer simulation** and modeling of cosmic radiation interaction;
- **Measurement** of cosmic radiation on aircraft and ground.

Cosmic Radiation dose measurements – Galactic and Solar:

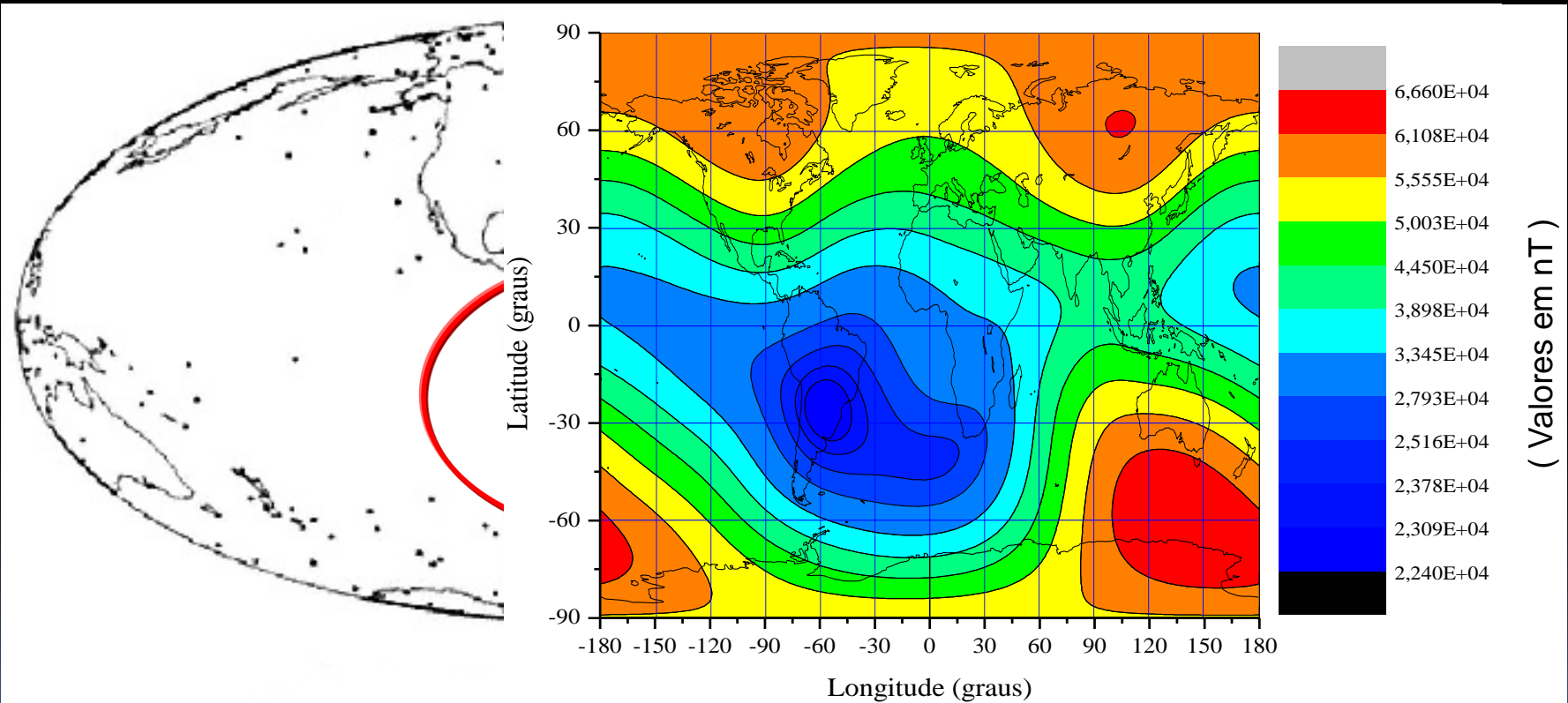
Two main points:

1 - The cosmic-ray can result in **accumulated dose** that may exceed the annual dose limit **for aircrews**.

2 - Another concern is the **radiation effects on devices and material used in aircraft** due to possibility of fails in specific devices, caused by cosmic rays induced neutrons, may compromise the **safety** of the aircraft

Effects on satellites:

- Permanent or transitory deviations in the electrical parameters or even complete failure of the systems
- Since 1975



RADIATION and the International
Washington, DC: National Academies

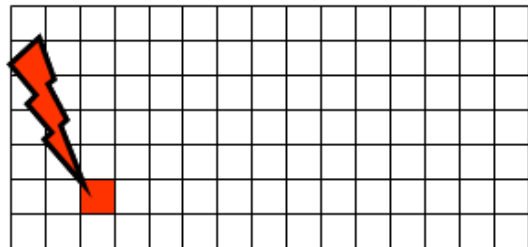
**Campo magnético terrestre a uma altitude de 12 km, calculado
utilizando o modelo geomagnético IGRF2011**

Effects on the aircrafts:

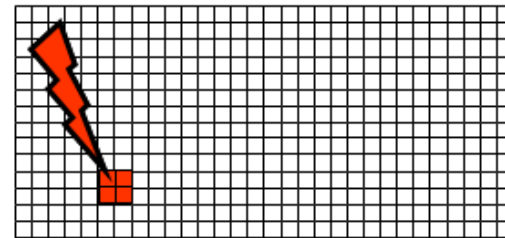
- About aircraft embedded systems



- 7 de outubro de 2008, um Airbus A330-303 operado pela Qantas Airways, a caminho de Perth para Cingapura, a 37.000 pés



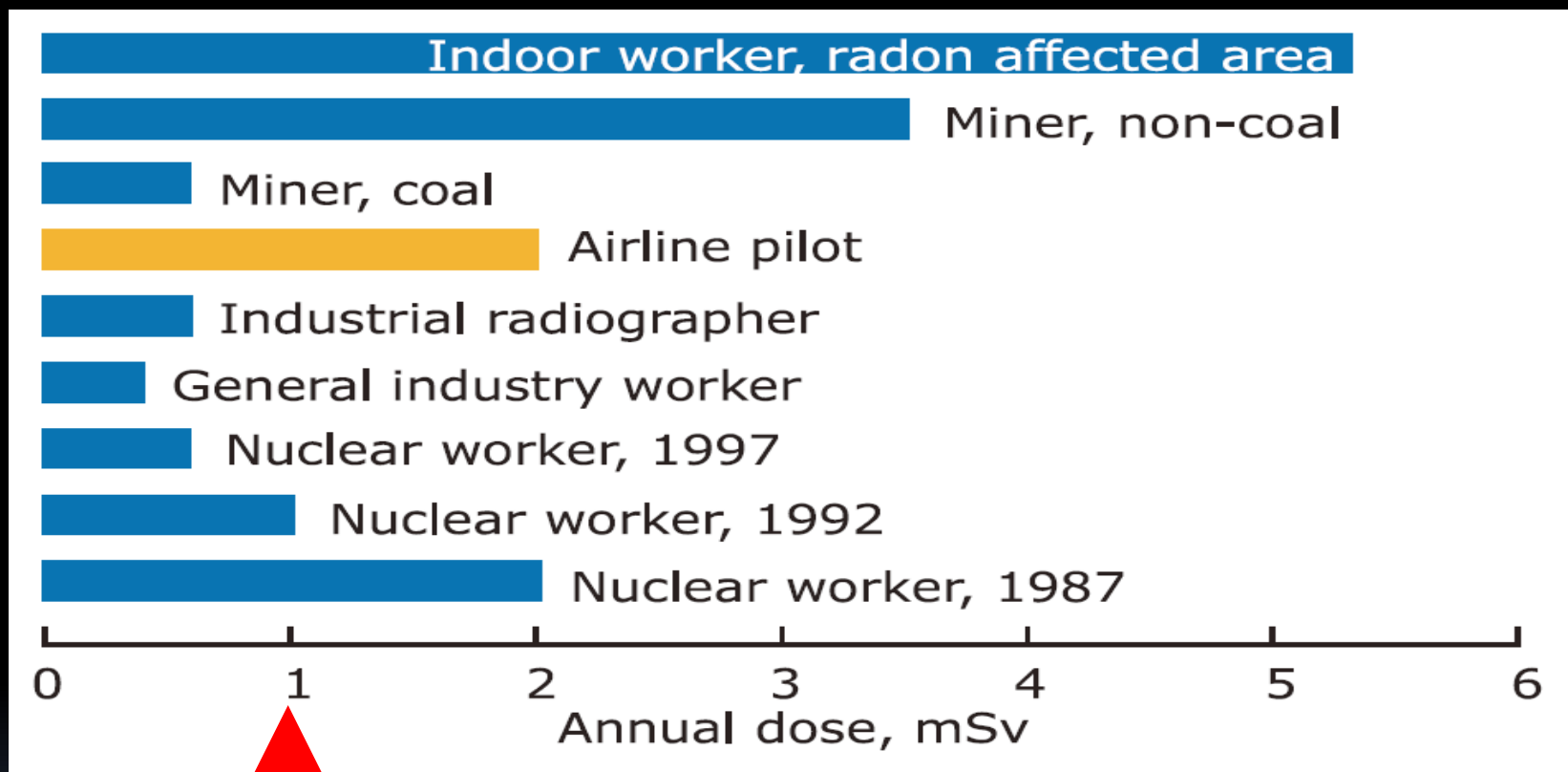
Single memory cell



Multiple memory cells

About aircrew...

Radiation doses



Bartlett, 2004

Annual limitation for public !

Especially concerning about female crew.

LRI – Laboratório de Radiação Ionizante (Ionizing Radiation Laboratory)



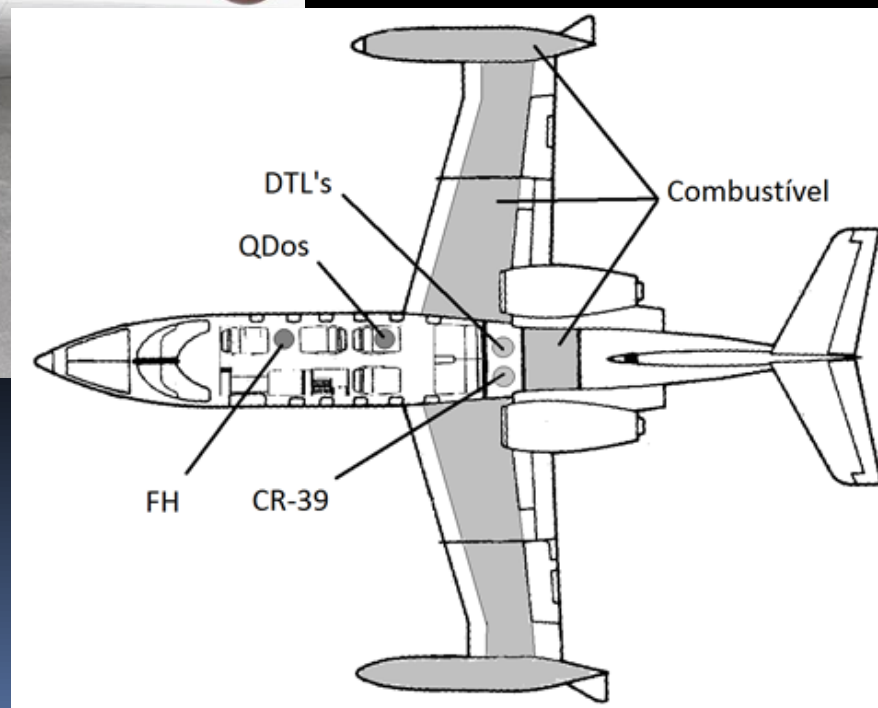
- The purpose of this laboratory is the research and development of technological applications of the ionizing radiation, particularly in space, aeronautics and defense.
- LRI contains: Two ^{60}Co irradiators (operational), some neutron sources, and we are including a high energy neutron source for avionics systems tests..



Measurements of ambient dose equivalent on flight



Learjet VU-35



Some measurement missions



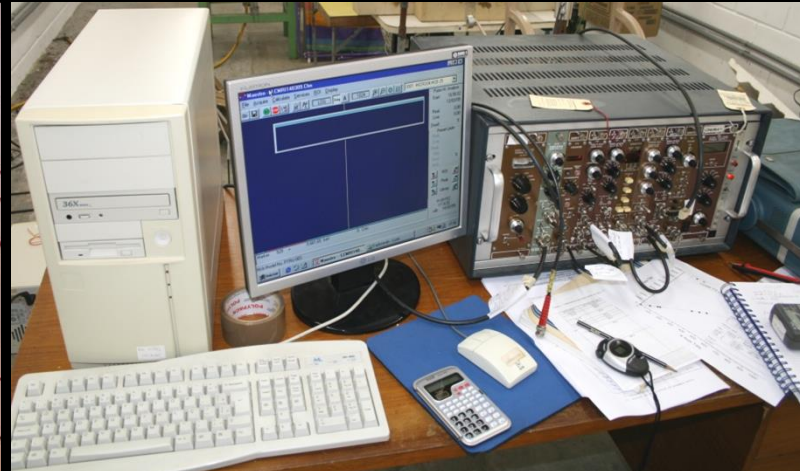
SAA
minimum
field

Some measurements

Bonner spheres spectrometer



Long-counter



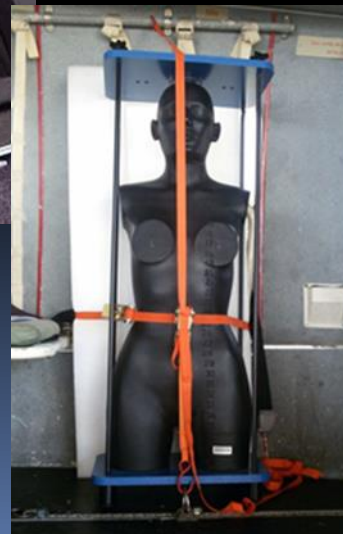
TEPC

PMMA and PEAD/Pb spheres with dosimeters

FH40-G(10) with probe
FHT-762



Phantom



Ground measurements

Acesso à Informação

BRASIL

OPD

ACROPOL



Pico dos Dias,
Brazil

Pic-du-Midi,
France



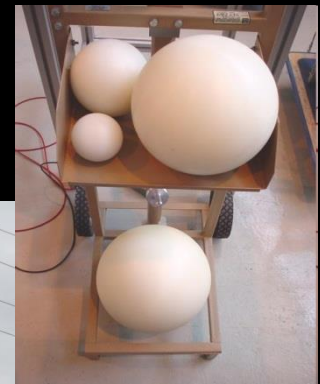
Sistema Nacional de Desenvolvimento das Atividades Espaciais

PNAE

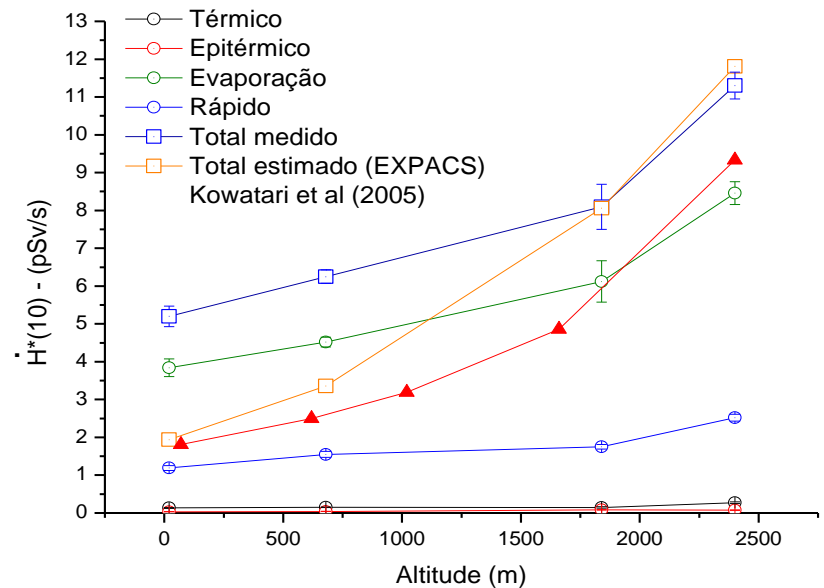
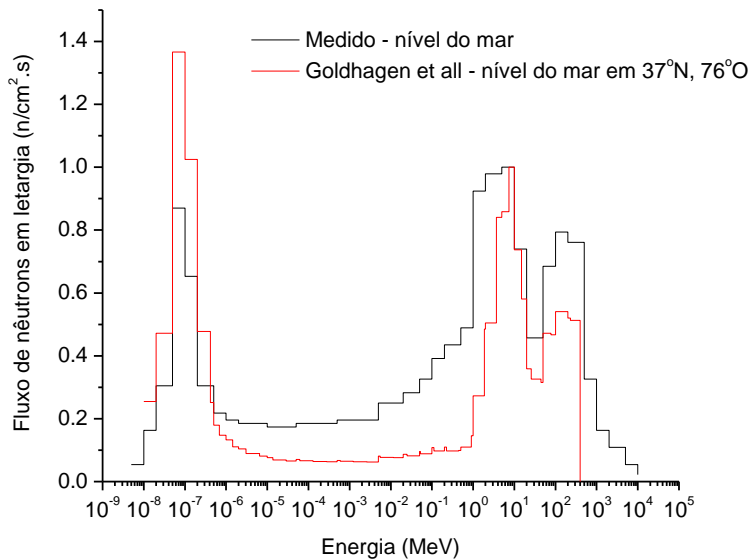
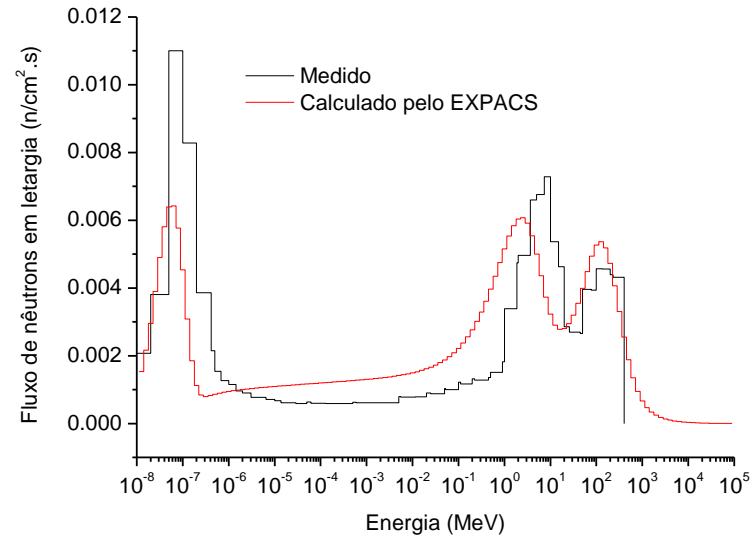
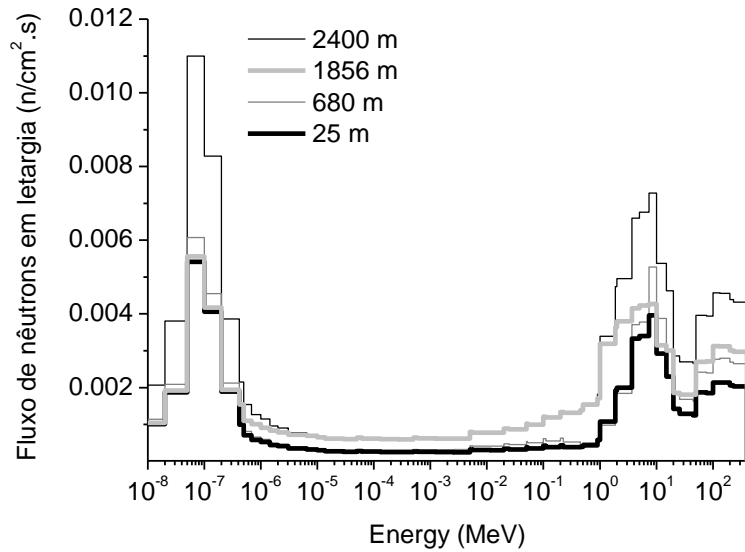
Programa Nacional de Atividades Espaciais 2012 -



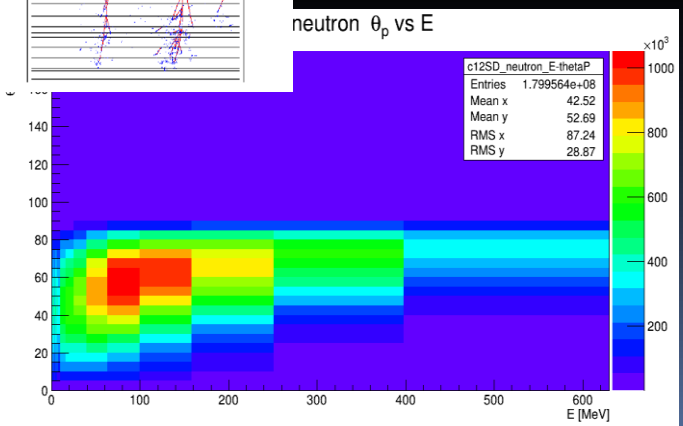
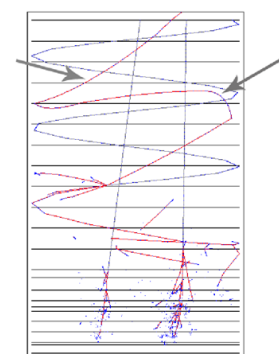
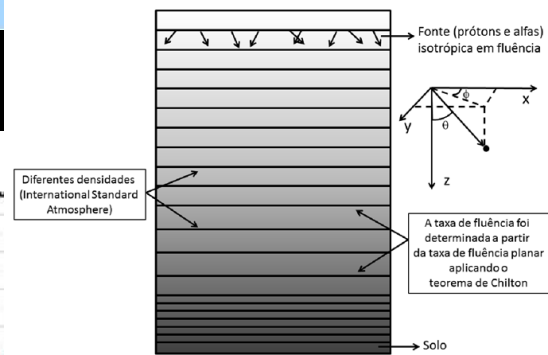
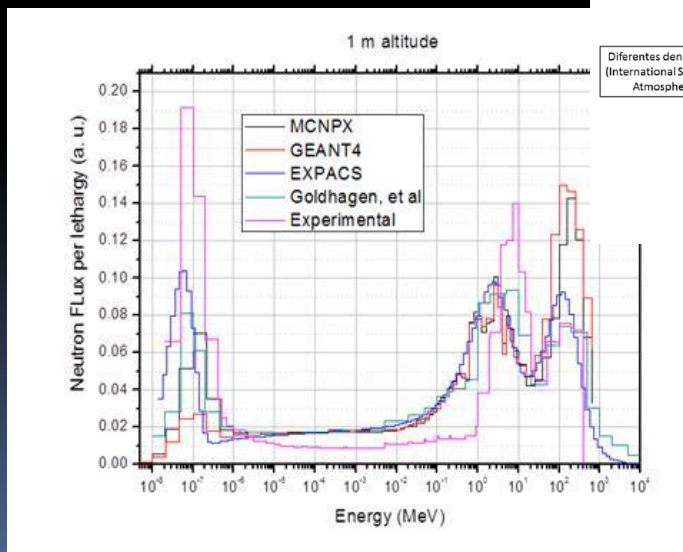
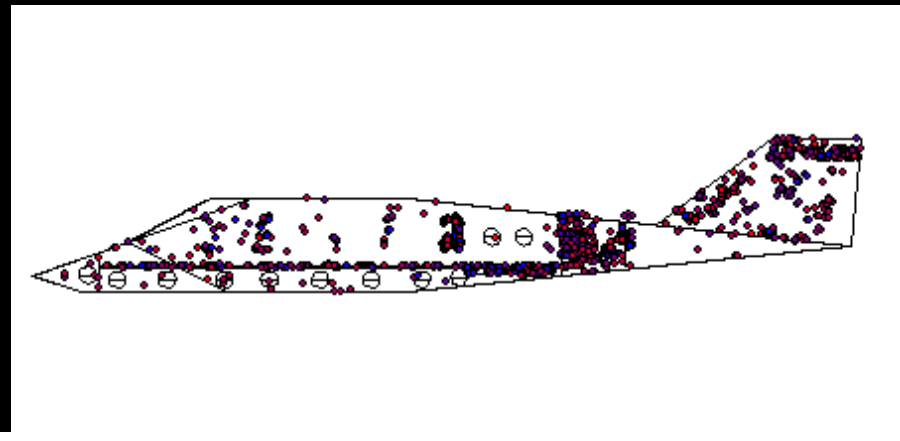
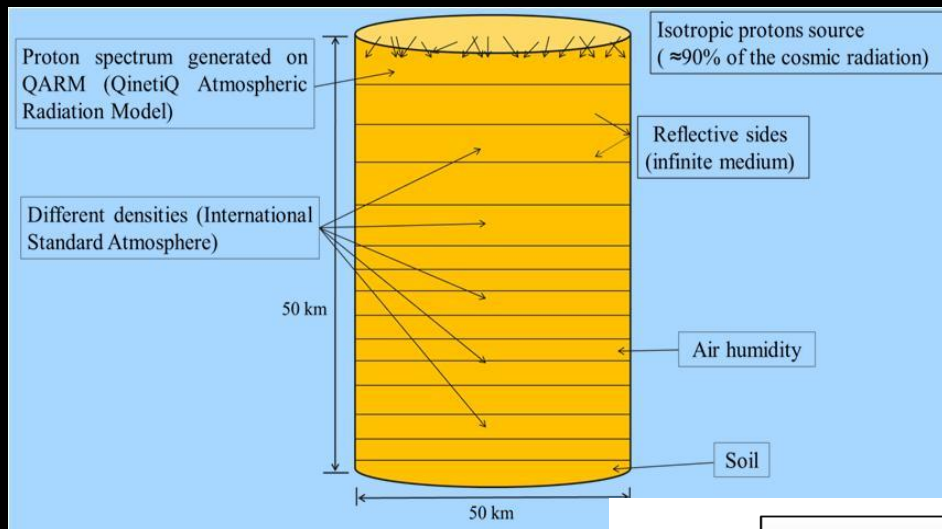
Ground neutron measurements



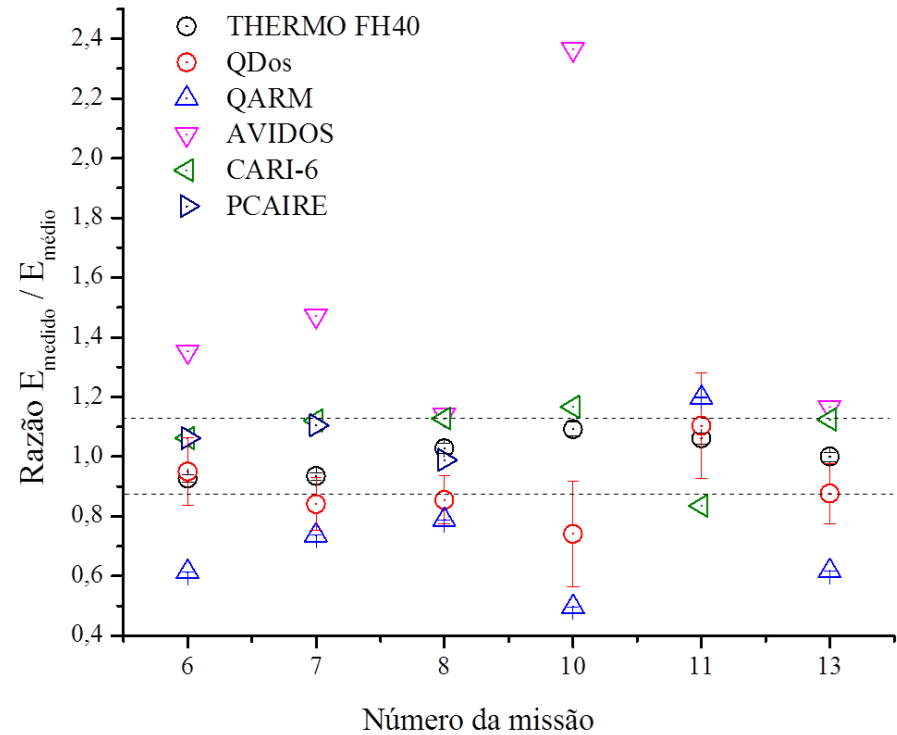
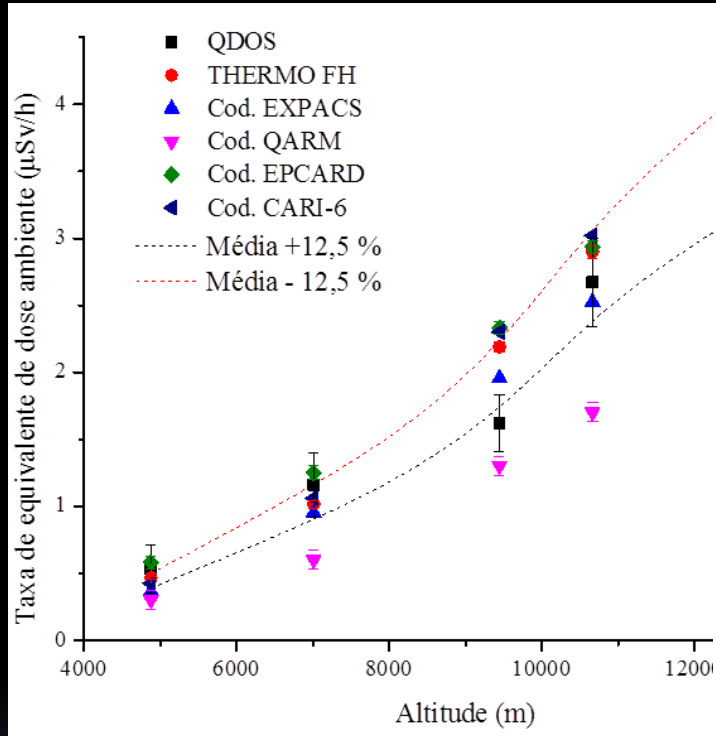
Some results



Cosmic rays computational simulation



Some missions results

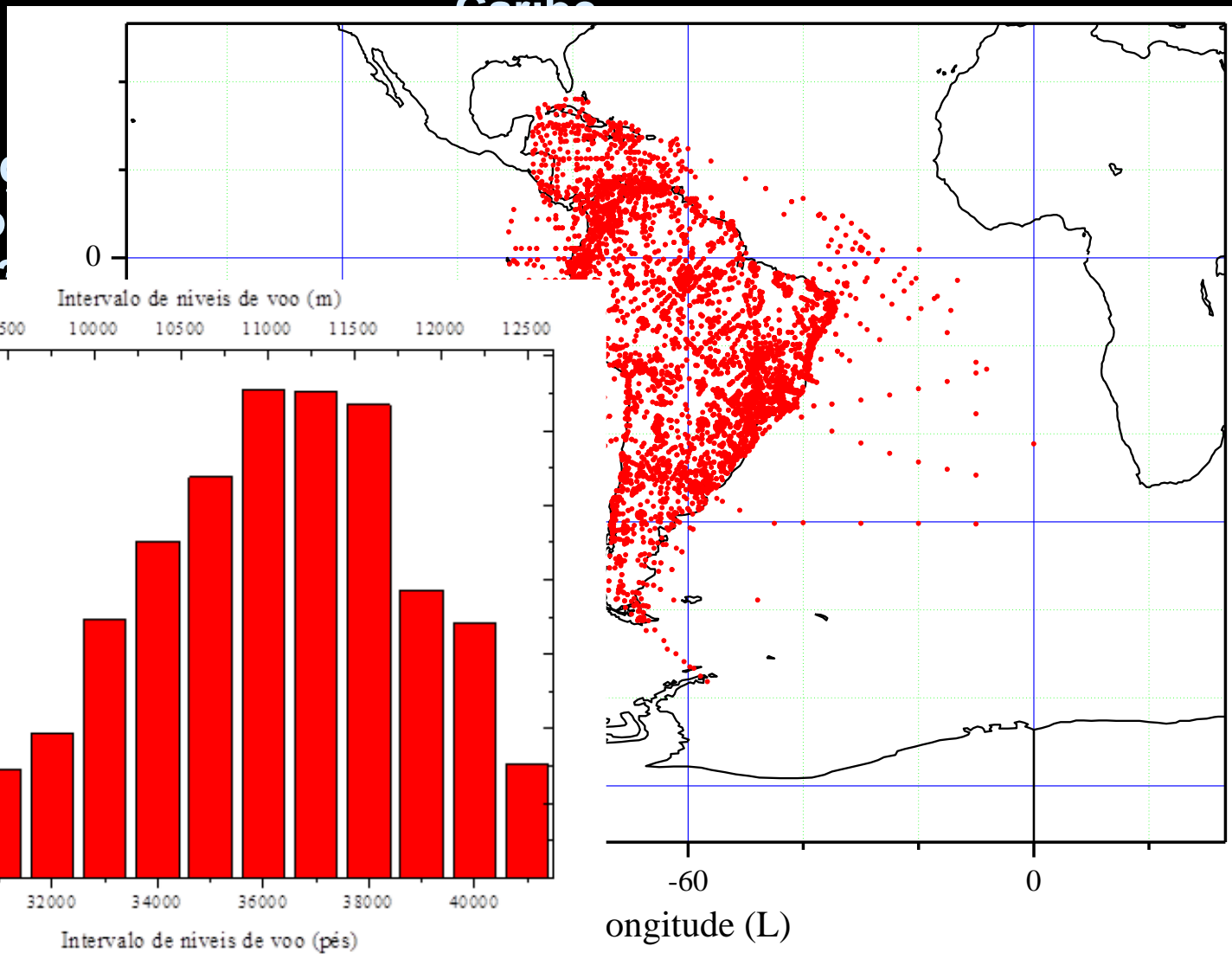


Desenvolvimentos e resultados

Estimativa do perfil de dose nas regiões da América do Sul e Caribe

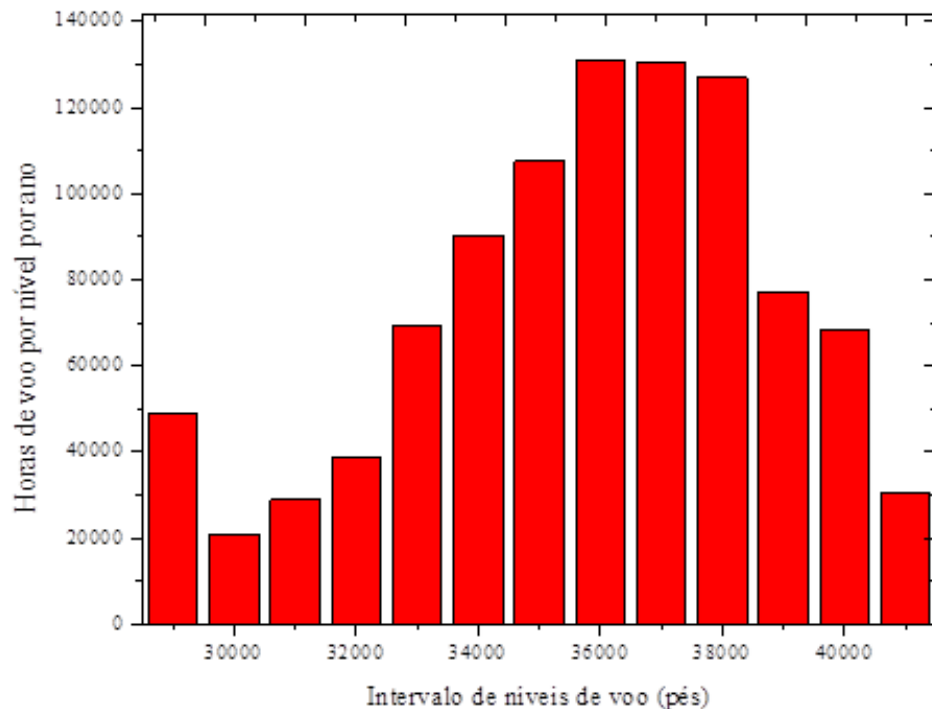
Amostra:

- espaço
- período
- 53162



Intervalo de níveis de voo (m)

9000 9500 10000 10500 11000 11500 12000 12500



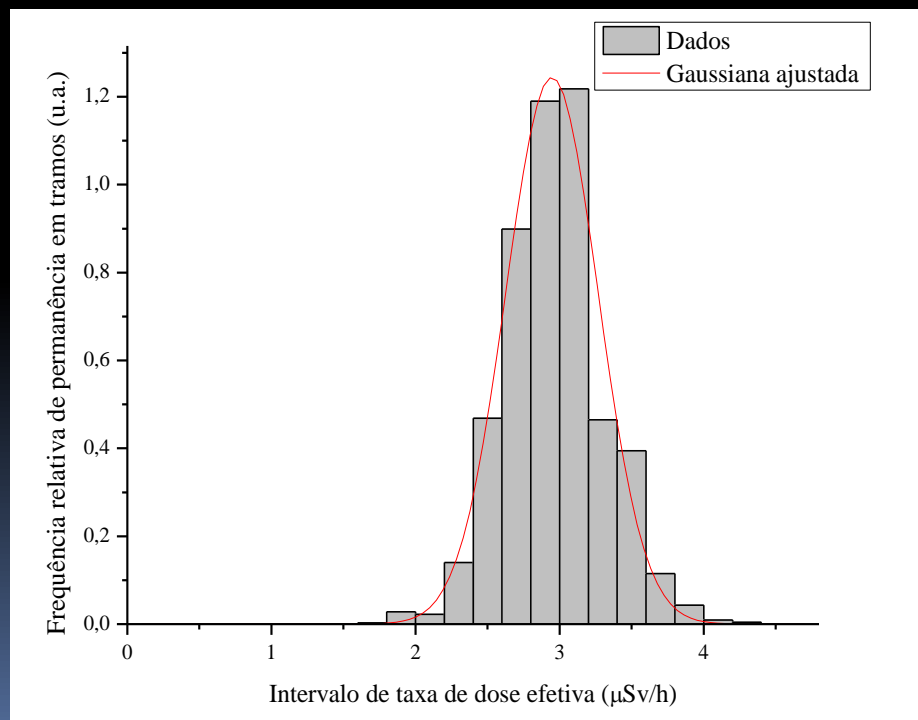
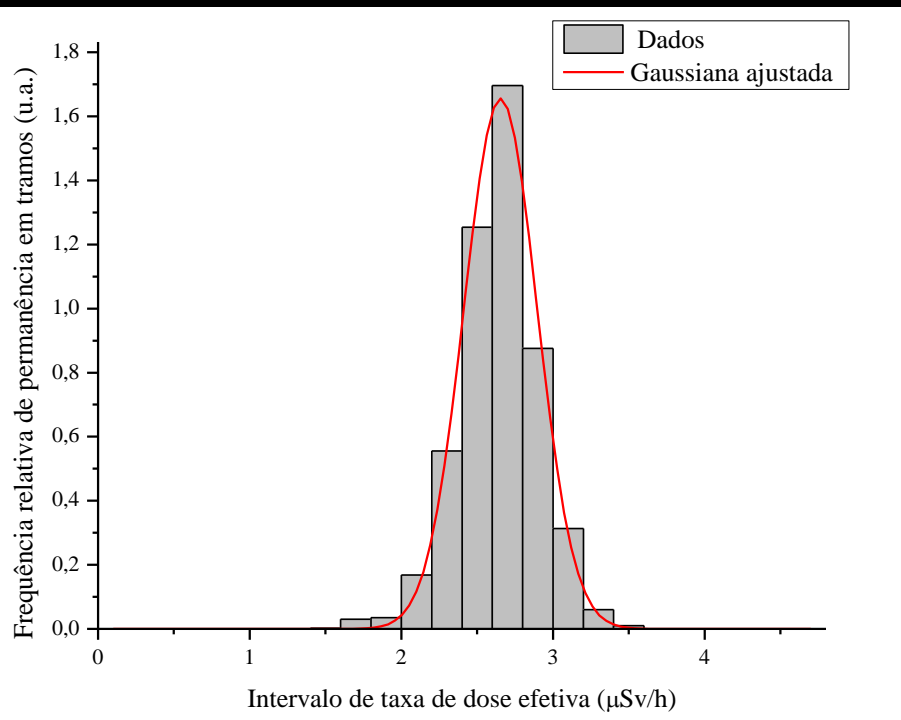
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Desenvolvimentos e resultados

Estimativa do perfil de dose nas regiões da América do Sul e Caribe

- Cálculo da taxa de dose efetiva média por tramo, ponderando pelo número de horas de voo em cada um dos 13 níveis.
- Redução de 40261 para 3097 registros de taxa de dose efetiva média por tramo, para cada potencial solar.



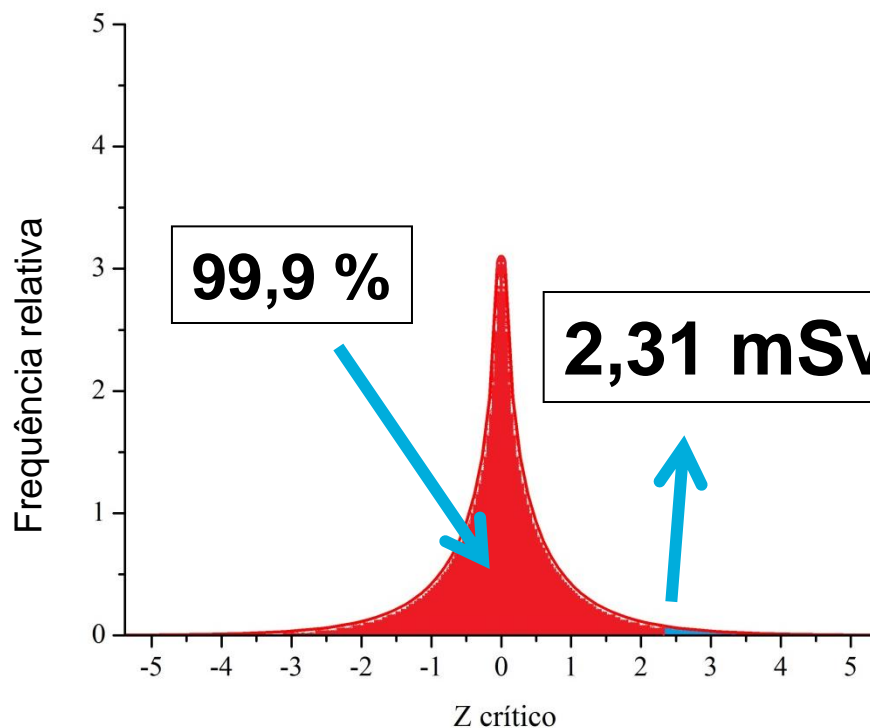
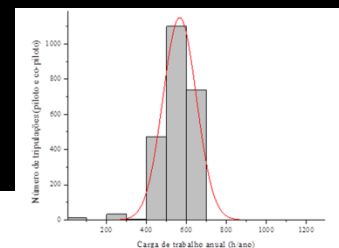
Desenvolvimentos e resultados

Estimativa do perfil de dose nas regiões da América do Sul e Caribe

\dot{E} máx. sol. = 1,45 mSv

\dot{E} mín. sol. = 1,67 mSv

$$E = \dot{E} \cdot \Delta t$$



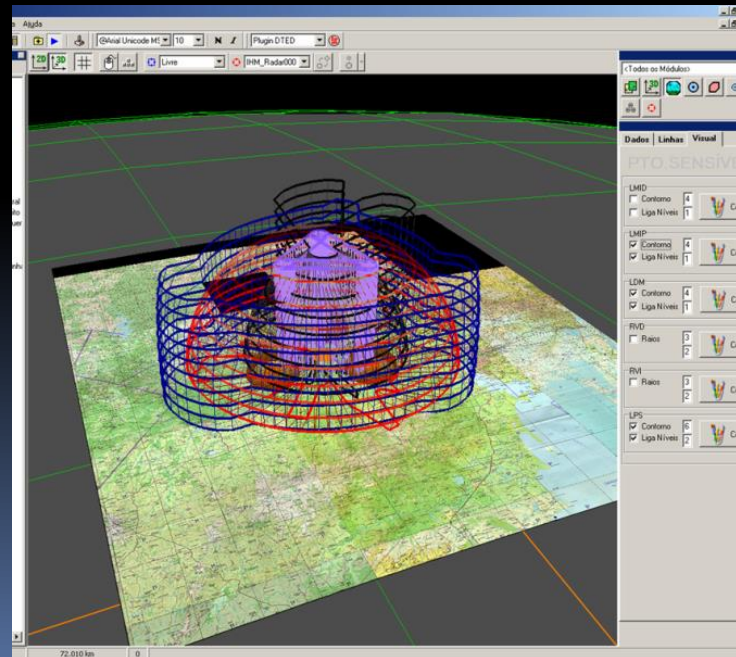
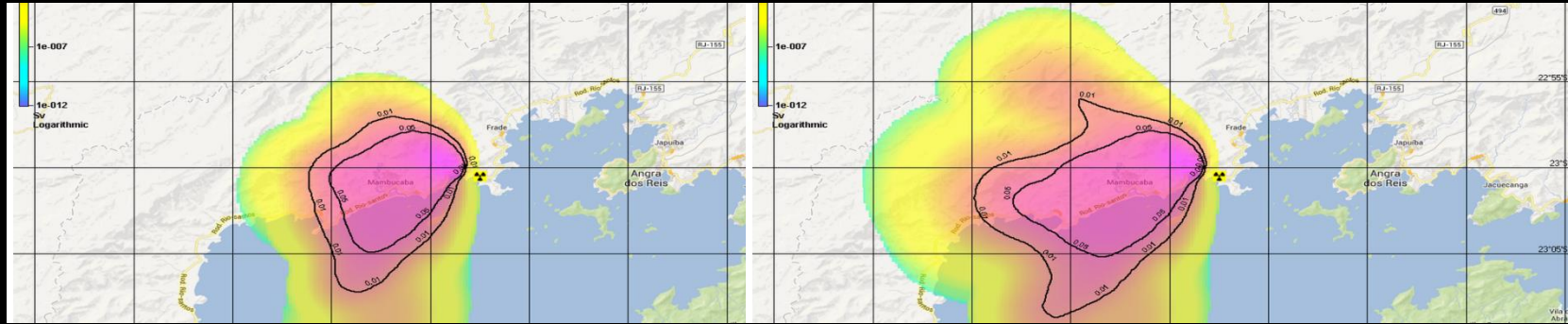
99,9 %

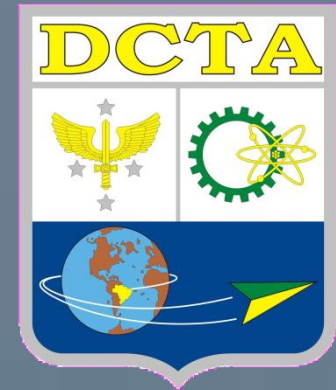
2,31 mSv a 2,73 mSv

3,15 % a (

More recently: technical support on simulation and measurement of radioactive plume on accident events.

Example of application of UAVs: Validation of the simulation results





END

Thank you !



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