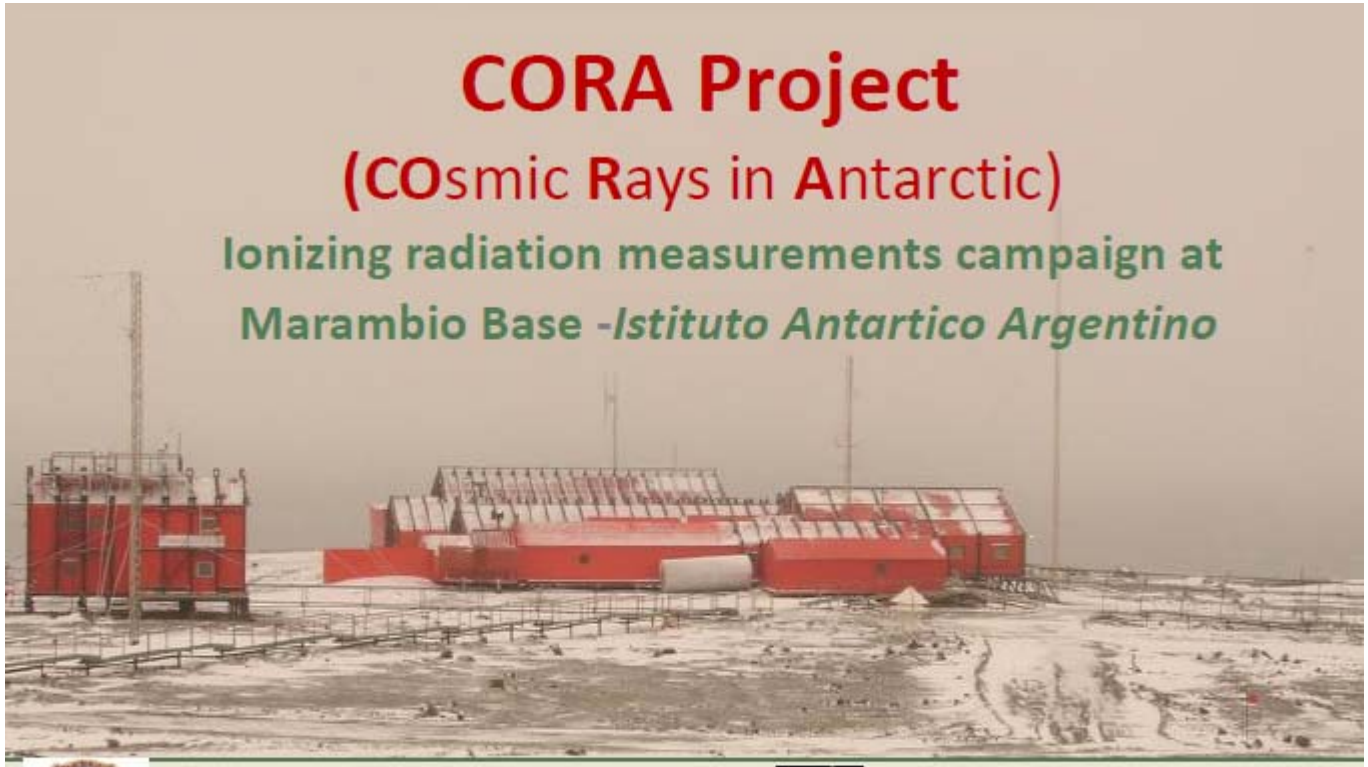
CORA Project

(COsmic Rays in Antarctic)

Ionizing radiation measurements campaign at Marambio Base -*Istituto Antartico Argentino*



Università di La Plata, Argentina

INFN Sez. Torino, Italy

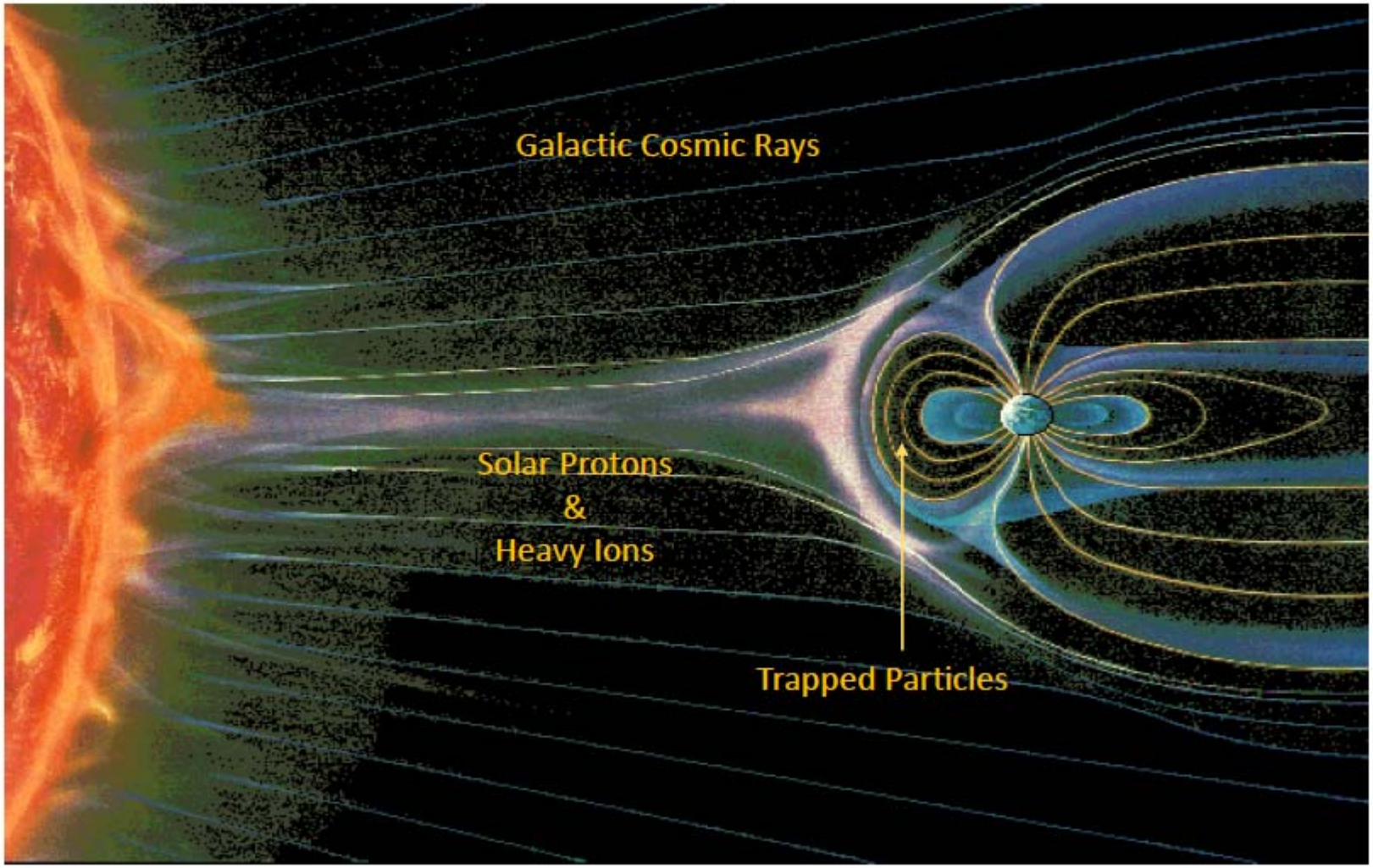
Ecole Internationale Daniel Chalonge, France

Università di Torino, Italy

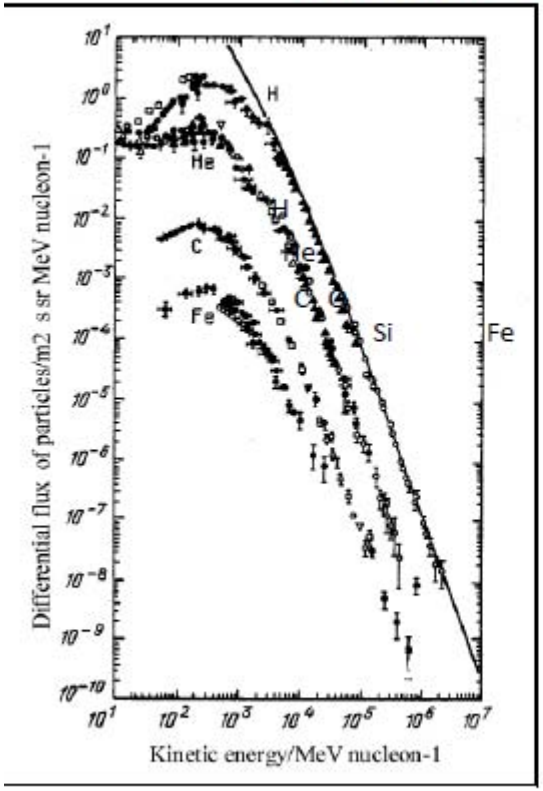
Collaboration

➢ INFN & University Torino, Italy	*Experimental measurements*
➢ INFN & University Trieste, Italy	*GEANT4 simulations*
➢ University La Plata, Argentina Space Medicine Department	Biological study
➢ Istituto Antartico Argentino	Logistic support
➢ INFN Bologna Italy	Track detectors analysis

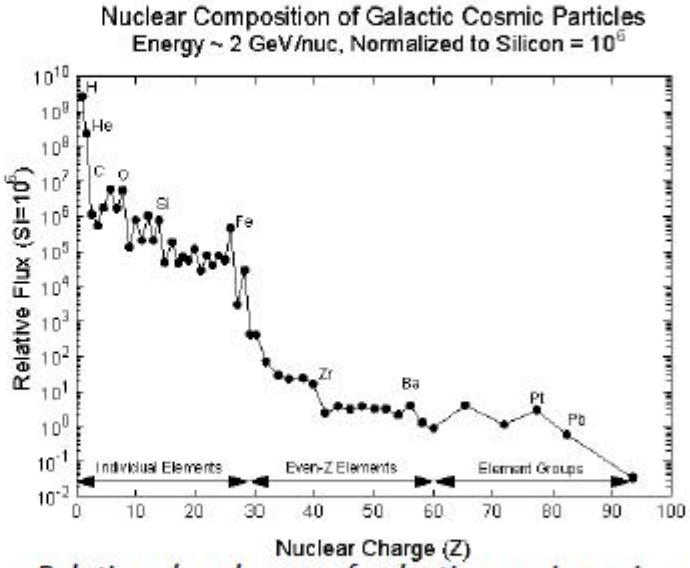
Earth radiation environment



Primary Cosmic rays composition



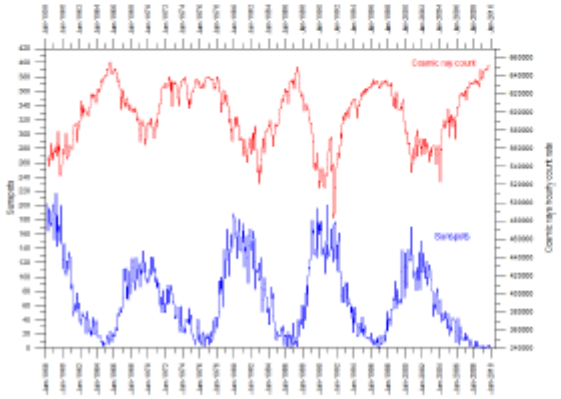
Energy spectrum of various components of primary cosmic rays



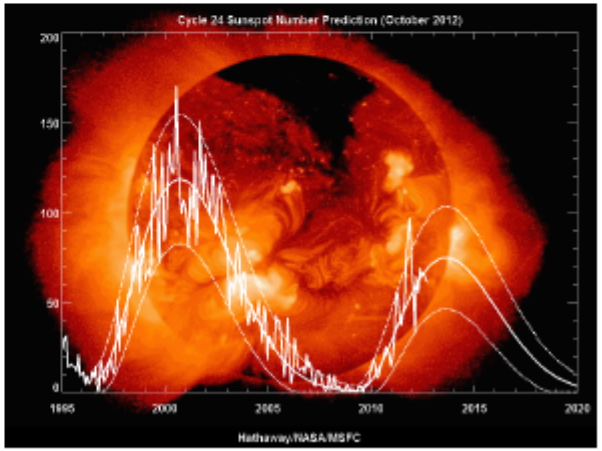
Relative abundances of galactic cosmic ray ions in interplanetary space. after Medwaldt

Cosmic Rays variability on Earth

The radiation environment and consequently the human being exposure, varies
1 –with altitude-because of the reduced thickness of atmosphere layer-
2- with latitude-because of the shape of the earth magnetic field-
3- with solar activity- because of the influence of solar wind on the galactic and extragalactic cosmic rays fluence, following a 11 years cycle.



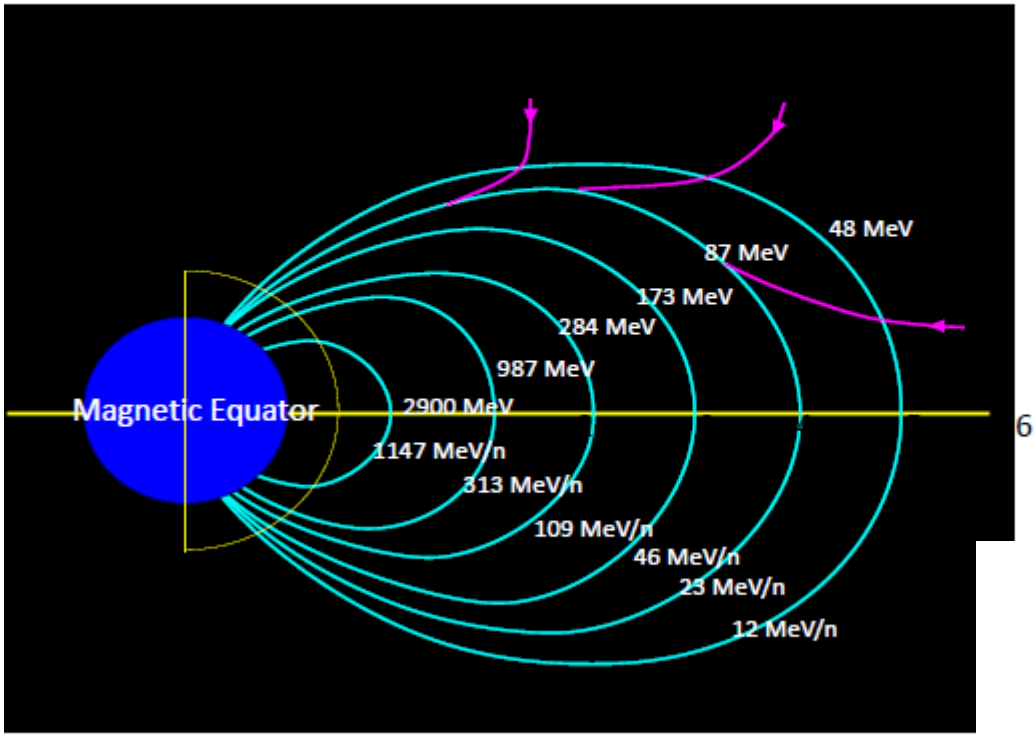
Variation of cosmic ray intensity (from Neutron Monitor data) and monthly sunspot activity



Variation of solar activity 11 years cycle

Magnetic Rigidity

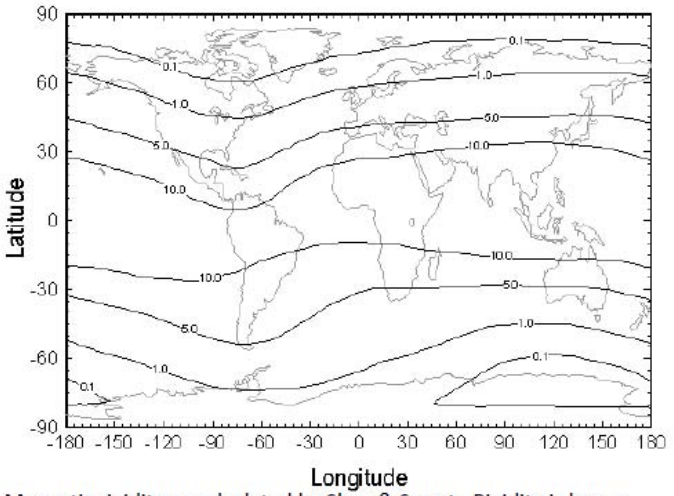
Total Energy Required to Penetrate the Magnetosphere



The geomagnetic cutoff rigidity is a concept that describes the geomagnetic shielding provided by the earth's magnetic field against the arrival of charged cosmic ray particles from outside the magnetosphere.

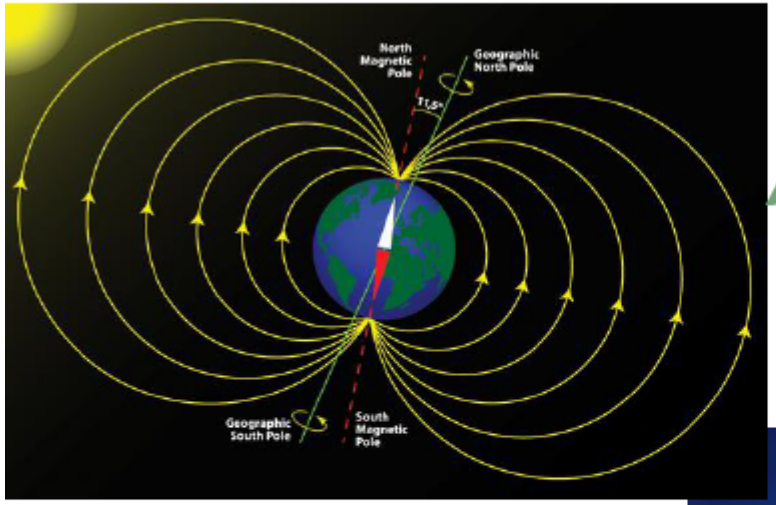
World Map of Geomagnetic Rigidity Contours at 800 km

After Shea & Smart, 1975 and Adams et al, 1981



Magnetic rigidity as calculated by Shea & Smart. Rigidity is lower at higher latitudes, allowing increased particle exposure near the poles.

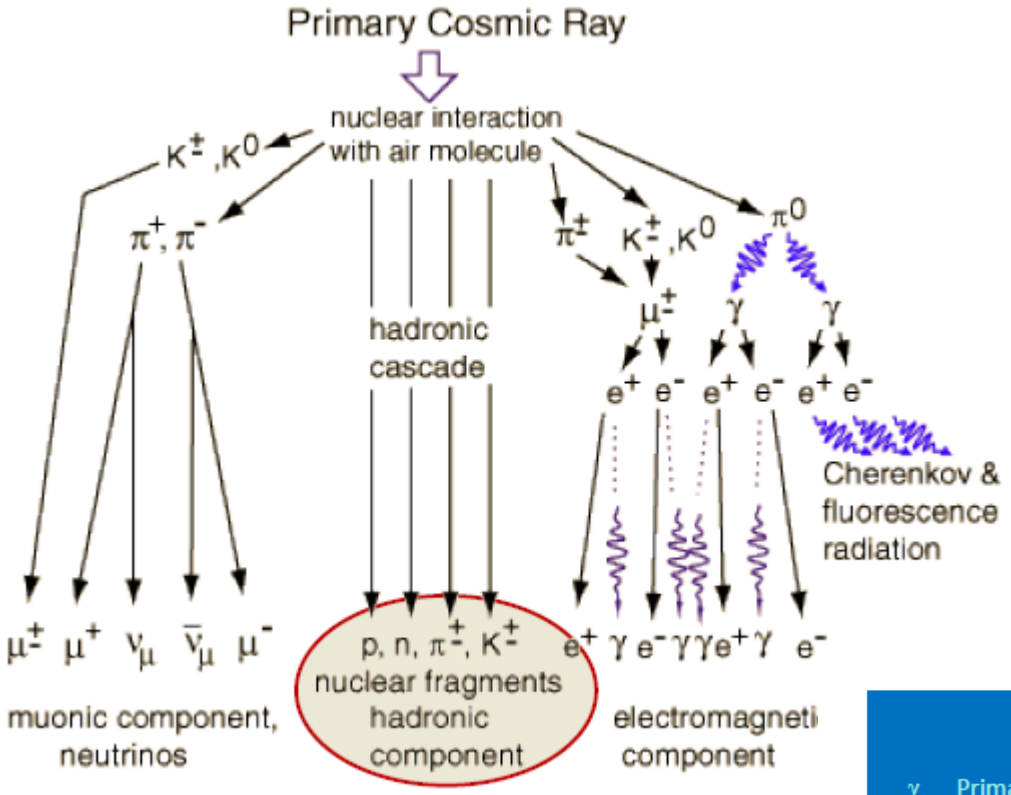
Maxximum Intensity of secondary atmospheric radiation

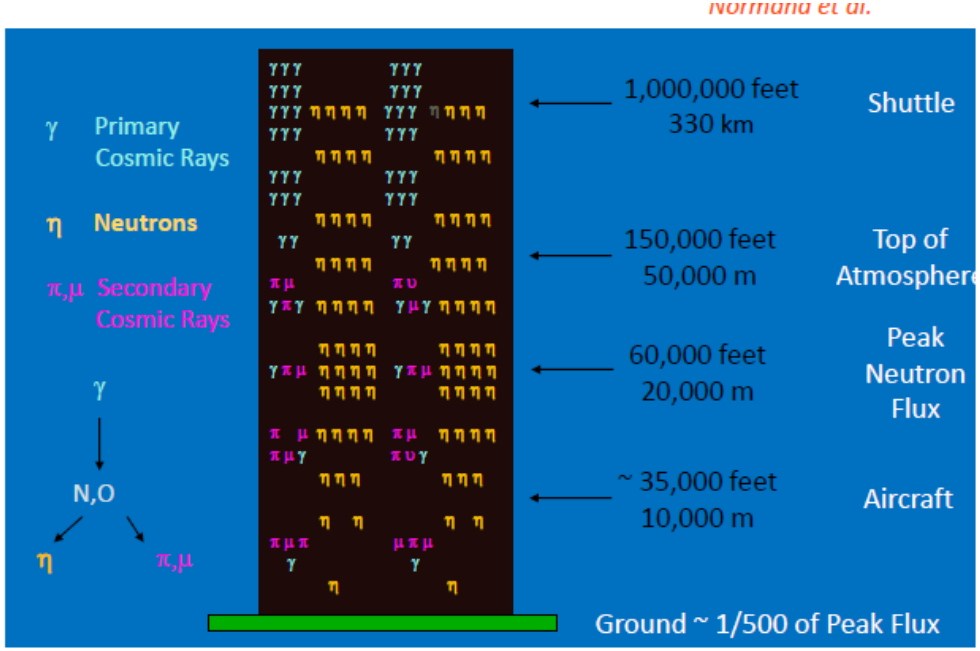


High altitude:
reduced atmosphere layer

High latitude:
Converging magnetic field lines

Neutron Environment





Secondary Neutrons in Atmosphere

Neutrons in atmosphere arise from:

1. interaction of primary cosmic rays with O and N atmosphere nuclei;

2. nuclear decays like:

$\Lambda \rightarrow n + \pi^0$

$\Sigma+ \rightarrow n + \pi^+$

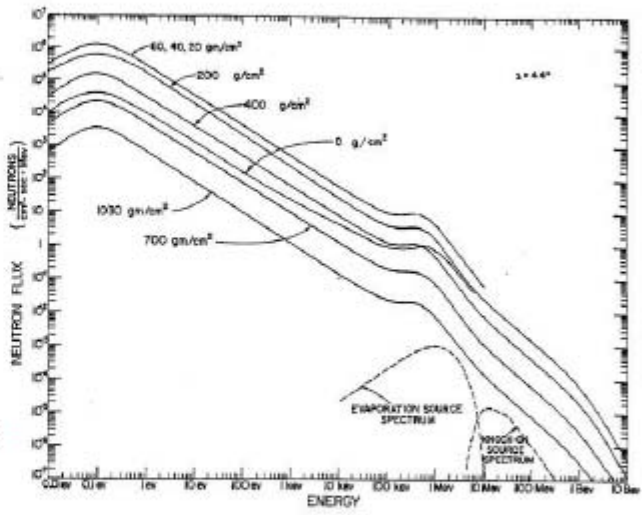
$\Sigma- \rightarrow n + \pi^-$

Most of the thermal neutron in atmosphere are absorbed in such processes a

$^{14}N + n \rightarrow {}^{14}C + {}^{1}H$

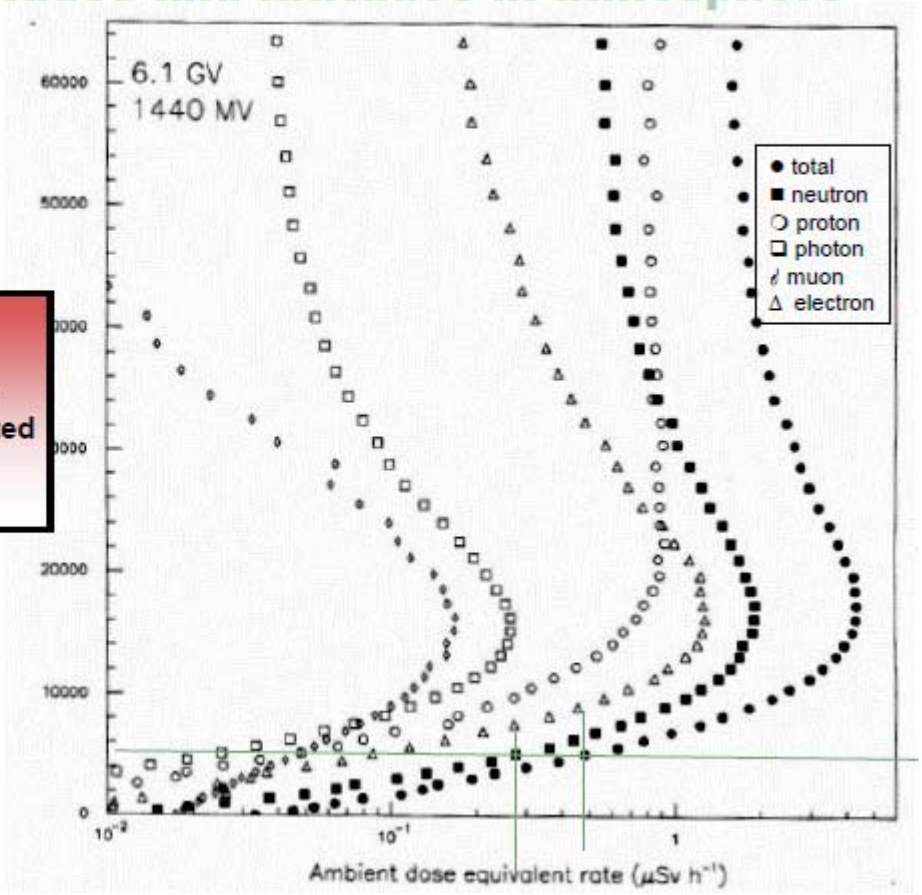
5% of neutron having energies greater than 4 MeV take part in the reaction:

$^{14}N + n \rightarrow {}^{12}C + {}^{3}H$



M. C. simulations and experimental data at various altitudes and latitudes in atmosphere

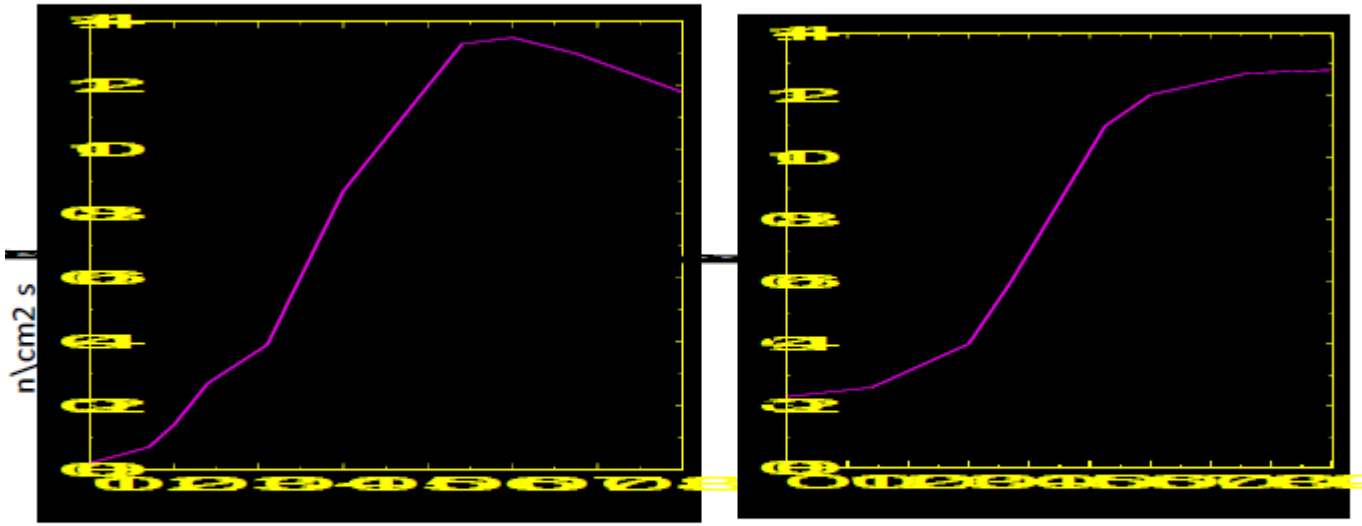
High latitude and maximum solar activity:
Ambient dose equivalent rate for different particles calculated using the FLUKA code.
(M. Pelliccioni)



H = 0.03 n
H = 0.05 tot

Neutron Flux vs. Altitude

Neutron Flux vs. Latitude



Altitude (Thousands of feet)

Latitude (deg N)

Janet Barth Military and Aerospace Applications of Programmable Devices and Technologies Radiation Environments

NASA/Goddard Space Flight Center

Grandezze fondamentali in dosimetria

Dose assorbita D (Gy= J/Kg)

$$D = \frac{d\,\overline{\varepsilon}}{dm}$$

Energia media depositata nel volume elementare di massa dm

Dose equivalente (Sv)

$$H_T = \sum_R w_R D_{T,R}$$

T = tessuto o organo

$D_{T,R}$ = dose assorbita dall'organo

w_R = fattore di qualità della radiazione

R = tipo di radiazione

Dose efficace (Sv)

$$E = \sum_T w_T H_T$$

H_T = dose equivalente

w_T = peso per il tessuto o organo

Qualche dato…

Per ricevere una dose di 1 mSv

17 mesi a Parigi

6 mesi in luoghi a grande altitudine

7 voli andata e ritorno Parigi-Tokyo

13 voli andata e ritorno Parigi-New York sul Concorde

1 ½ giorni a bordo della MIR (400 km di altezza)

Per un dato volo, la dose totale della radiazione cosmica ricevuta è direttamente proporzionale alla durata dell'esposizione, e quindi alla durata del volo.

Occupazione	Esposizione annua (mSv/anno)
Addetti centrali nucleari	4.76
Tecnici di radiografia industriale	3.34
Personale reparti medicina nucleare	1.22
Piloti e assistenti di volo	1-5

Dose alla popolazione 1 mSv/y **Dose professional exposure 5 mSv/y**

Exposure in Space Missions

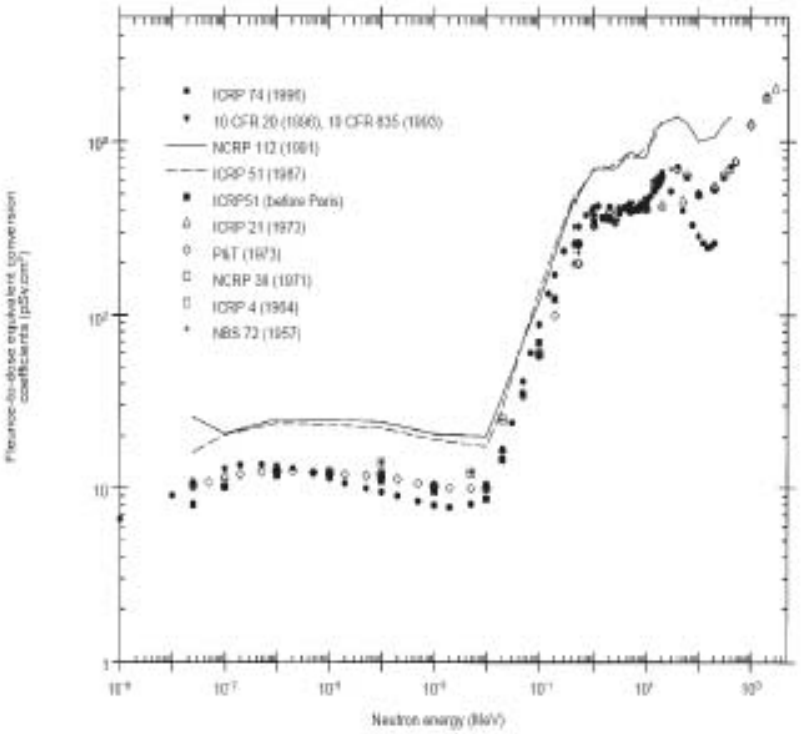
Program	Average altitude in km	Crew members	Dose-rate in mSv/day	Total dose in mSv
Gemini	454 (1370)	20	0.87 (4.7)	0.53 (4.7)
Apollo		33	1.3 (3.9)	12.2 (33)
Skylab	381 (435)	9	1.2 (2.1)	72 (170)
Mir	341(355)	4	0.72 (1.0)	100 (140)
ISS	360 (450)	280	0.5 (1.0)	80 (180)
Mars		4 (8)	1.5 (2.0)	400 (1200)

Livelli di radiazione stimata o misurata nelle missioni spaziali (in parentesi sono riportati i valori massimi).

Ref.: M. Durante "Radiation protection in space", La Rivista del Nuovo Cimento, 25-4-8 (2002).

Neutron Dosimetry

Types of radiations and energy intervals	Weighting factors of radiation, W_R
Photons, all energies	1
Electrons, all energies	1
Mesons, all energies	1
Neutrons energies < 10 keV 10 – 100 keV 100 keV – 2 MeV 2 – 20 MeV > 20 MeV	5 10 20 10 5
Protons Heavy Ions	5 20



Neutron Conversion factors from fluence to ambient dose equivalent ($mSv.cm^2$)

It is evident that weighting factors strongly depend from neutron energy.
As a consequence, to evaluate accurately the neutron dose, it is required the evaluation of neutron energy spectrum, that for atmospheric secondary neutrons, extended from thermal energies to hundred of GeV. For this reason the assessment of neutron dose requires different detectors in different energy range.

Risk for the health: *humans are exposed to a complex mixed radiation field*

- In space
- in high altitude flights
- In high altitude countries
- In high latitude countries

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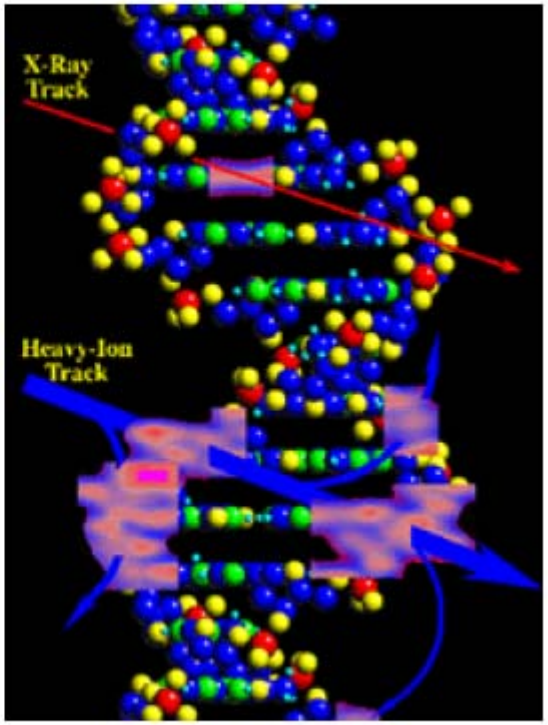
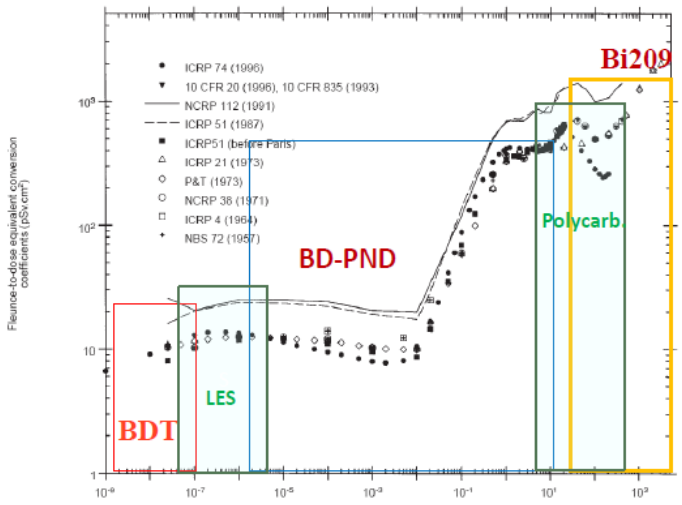


Neutron dose evaluation

An accurate neutron dose evaluation is very complex because:

- Fluence to dose equivalent conversion factors strongly depend from neutron energy.
- For an accurate dose evaluation it is necessary to know the neutron energy spectrum.
- Secondary neutron energy range varies from thermal energy (0.025 eV) to hundred of GeV
- Different detectors are required , based on different physical effects
- The detector responses are elaborated by using a mathematical unfolding code

Fluence to neutron dose equivalent conversion factors



Why dosimetric measurements in Antarctica?

- No data in literature (in particular on neutron dose)
  - only X-rays measurements and
  - dose evaluation for the Power Plant decomissioning at Mac Murdo base (1979)
- High latitude effects
- Effect of pressure in Antarctic : increases the secondary cosmic rays flux
- Evidence of decreasing in Magnetic field at South Pole
- Effects due to solar flares , geomagetic field variability
- Deplacement of the South Pole

- People living at the antarctic bases for long period (>1 year)
- Study of low doses exposure

➢ Relationship between cosmic-ray intensities and atmospheric pressure

There is a relationship between the neutron dose rate and the atmospheric pressure in the monitoring period. The main component of the cosmic-ray measured at ground level is secondary cosmic-ray, and is attenuated by the air above the ground which acts as a shield. The cosmic-ray neutrons and the ionizing components measured at ground level vary according to an exponential attenuation law with the atmospheric pressure in the form of ~exp(-A·P).

$$N(Po + P) = N(Po) \exp(-aP).$$

- The largest deviations occur over Antarctica where ground level pressures are 20–40 hPa (hectoPascal) lower than the standard atmosphere (corresponding to a lower atmospheric mass). Secondary particle production rates in Antarctica are therefore 25–30% higher than values calculated by scaling Northern Hemisphere production rates with conventional scaling factors.

➢ Continued Decline of South Pole Neutron Monitor Counting Rate

John Bieber e al.

Journal of Geophysical Research: Space Physics
Volume 118, Issue 11, pages 6847–6851, November 2013

....At this time therefore we believe that there is a solid justification for a program to investigate in detail geomagnetic cutoff change at South Pole and its influence on the radiation environment

PoGOLite: Neutron Background Studies forHigh Latitudes. 2012

Maria Fernanda Muñoz Salinas
SH2006: Project Work in Physics , Stockholm, Sweden

The Polarised Gamma-ray Observer (PoGOLite) is a balloon-borne instrument which is able to measure the polarisation of X-rays and soft gamma-rays. During the first flight of PoGOLite realised on July 2011, measurements of the background radiation were made.The measurements showed a neutron background ten times higher than expected. The neutron background was simulated with PLANETOCOSMICS.

Rapid decrease in total magnetic field F at Antarctic stations - its relationship to core-mantle features

Antarctic *Science* ***14 (I), 61-68 (2002***

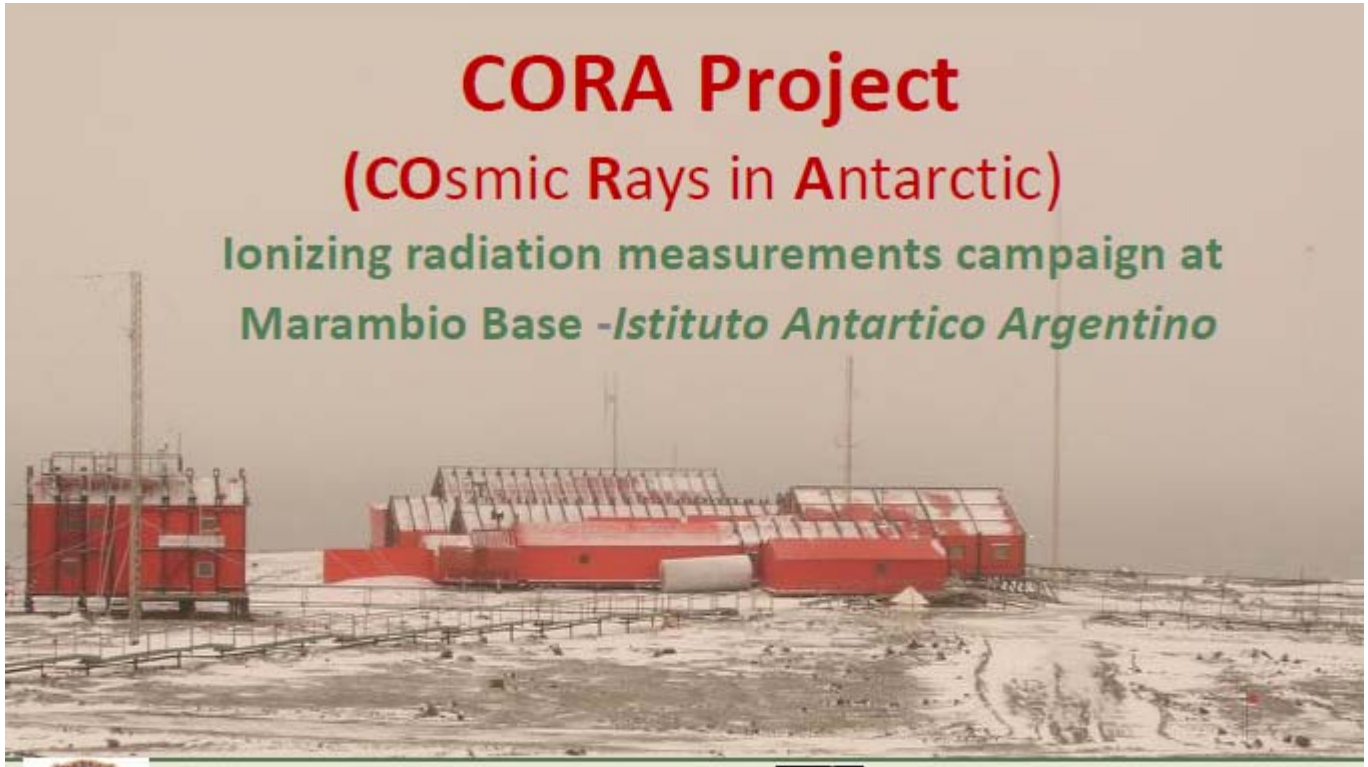
GlRIJA RAJARAM, T. ARUN, WAY DHAR and A. G. PATIL
Indian Institute of Geomagnetism, Colaba, Mumbai 400 005, *India*

Comparison of the average quiet-time value of total intensity F for these years with values of F obtained at the same geographic location (interpolated from iso-intensity contours of *F* on World Magnetic Charts and IGRF Maps) for earlier years, suggestedover the last 75 years at this location, Fhas dropped from -49 000 nT in 1922,
to -40 000 nT in 1996 i.e. -120 nT per year.

CORA Project

(COsmic Rays in Antarctic)

Ionizing radiation measurements campaign at Marambio Base -*Istituto Antartico Argentino*



Università di La Plata, Argentina

INFN Sez. Torino, Italy

Ecole Internationale Daniel Chalonge, France

Università di Torino, Italy

2013 Campaign

Instrumentation at Marambio Base

Bubble Detectors

- BDT 0.025 eV
- BD-PND 100 keV -20MeV

- Bi209 stack (ANPA)
  200 MeV-400 GeV

- Rem Counter 2222A
  0.025 eV-17 MeV

NEUTRONS

Liulin 1 LET spectrometer

ELECTROMAGNETIC SHOWER
All energies

Active detectors

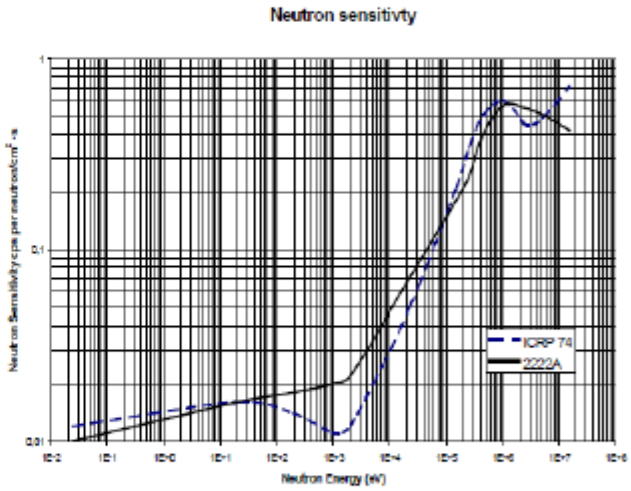
NEUTRONS

Rem Counter 2222A

The Rem Counter neutron detector is constituted by a BF3 counter embedded along the center axis in a 30-cm-diameter and 32-cm-height paraffin cylinder ; the detector allows to measure the ambient dose equivalent rate and the integral ambient dose equivalent for neutron in the energy range **0.025 eV- 17 MeV.**
The monitor shows the ambient neutron dose equivalent in terms of mSv/h and in terms of integral dose (mSv)

Rem Counter 2222A

Wedholm Medical AB Rem counter 2222A



2222A Rem Counter Response

Passive detectors

- Passive detectors are very suitable for in field measurements, as lintercontinental flights, onboard spacecraft and in extreme environment , because of their small size, low weight, lack of need of electrical power

- For neutron ambient dose equivalent evaluation two different sets of detectors are employed

1) **Short range spectrometer (10 keV-20 MeV**) based on BDS (BTI) bubble detectors
2) **Wide range spectrometer (0.025 eV- 100 GeV)** based on for different neutron detectors

- BDT - thermal energies
- BD-PND 100 keV – 20 MeV
- Polycarbonate 1 MeV 100 MeV
- Bi209 fission stack (ANPA) 50 MeV-100 GeV

3) **Unfolding code BUNTO**

Passive Neutron detectors

1- Bubble detectors

The detector is constituted by a vial filled with a tissu polymer, in which drops of a superheated liquid (freo dispersed.

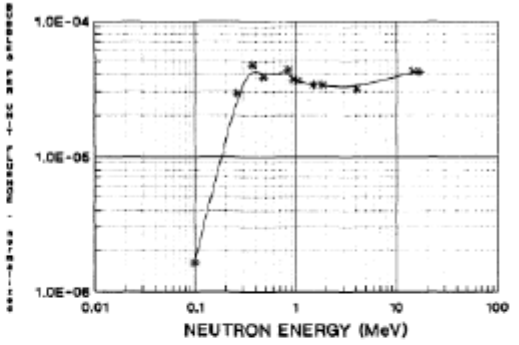
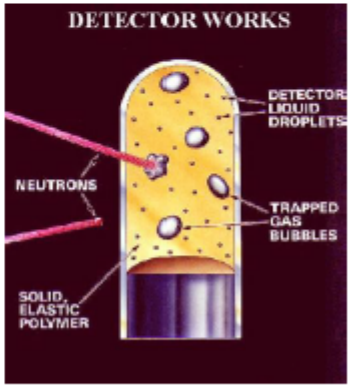


Figure 3: Measured energy dependent response of bu detectors.

- Two different types of detectors, with different chemical composition of the liquid, different threshold and energy response are available
  - **BDT** low energy neutrons (0.025 eV – 0.4 eV)
  - **BD-PND** high energy neutrons (100 keV-20 MeV)

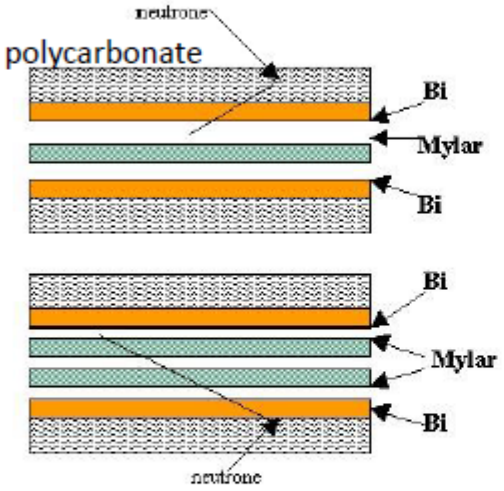
- The system works using the superheated drop detector mechanism: the charged recoils particles produced by the interaction of neutrons with the polymer nuclei transfer their energy to the superheated drops, which become bubbles trapped in the gel. Their number is related to the neutron dose according to the factory calibration.



Bubble detector working scheme

Passive Neutron detectors

2- ^{209}Bi detector (50MeV-100 GeV).

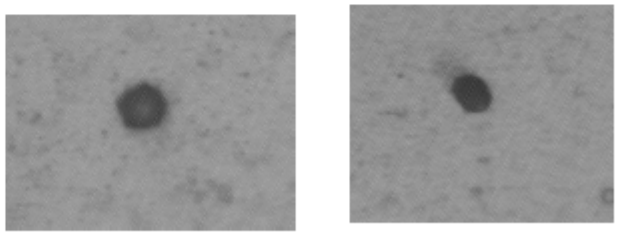


Bismuth detector scheme

The Bi-radiators are made of a 25 mg/cm2 bismuth film deposited on 100 μm PET-polyethylene terephthalate (PET)- film, which acts as a bismuth film support.

Calibration at PSI , Zurich

The Bismuth stack consists of alternate mylar (0.125 mm) and bismuth layers (0.025 mm) . When the neutron crosses the stack, a fission event can occur in the bismuth layer, generating fission fragments that produce a track damage in the mylar layers.
Tracks can be counted after electroetching or chemical etching and their number is related to the high energy neutron dose, following the detector response curve



An exemple of neutron tracks on mylar after electro-etching. (INFN Bologna, Italy)

Passive Detectors (Neutron component)

WIDE ENERGY RANGE 0.025 eV (Thermal)- 100 GeV

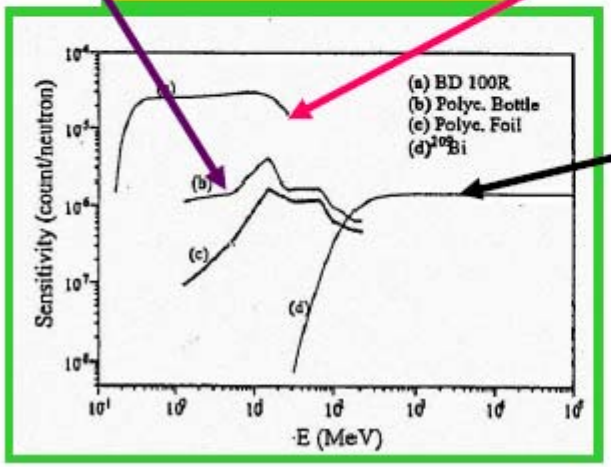
Bubble dosemeters

BD-PND 100keV - 20 MeV

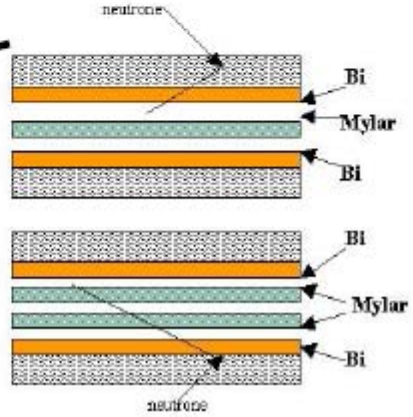
BDT Thermal neutrons

Polycarbonate detectors
1MeV-100MeV

RESPONSE CURVES

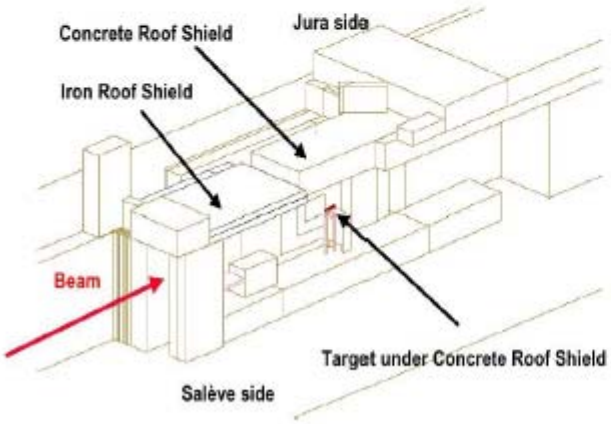


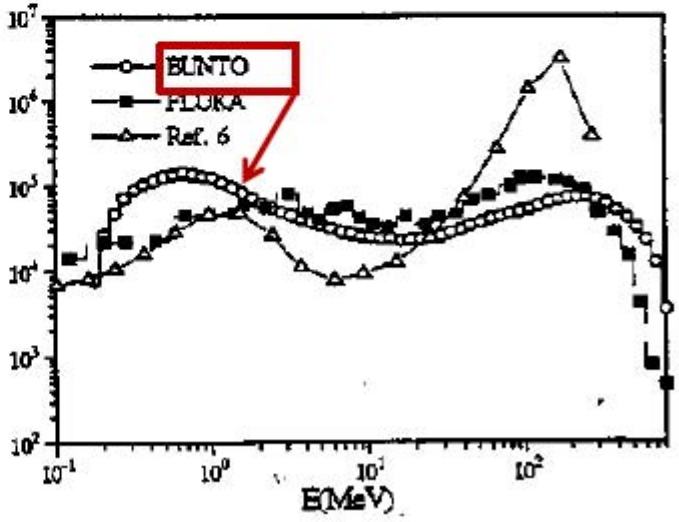
Fission detector ^{209}Bi 50Me -100GeV



Calibration at CERF

- The calibration of the passive detector system has been performed at CERF (T14 position, H-6SPS beam): this facility is a reference field for the calibration of neutron detection systems to be used in the cosmic ray field.
- The passive detector results, unfolded with the BUNTO code, are compared with the MC simulation of the experimental setup: the results are consistent





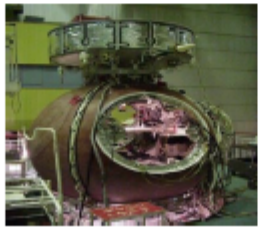
Neutron Dosimetry
(INFN - ALITALIA - ASI - ESA –NASA projects)

1. **High mountain laboratories**
   Plateau Rosa, Testa Grigia Laboratory
   h=3480 m,
   45° 56' 03'' N, 7° 42' 28'' E
   Chacaltaya, La Paz (Bolivia)
   h=5400m, 16°S

2. **Alitalia flights** AZ784/11, AZ784/12
   Roma-Tokyo-Roma
   h=11500m,
   35° 45' 9'' N, 14° 23' 2'' E
   Milano- L.A.-Milano
   68° 30' 5'' N, 7° 33' 4'' E

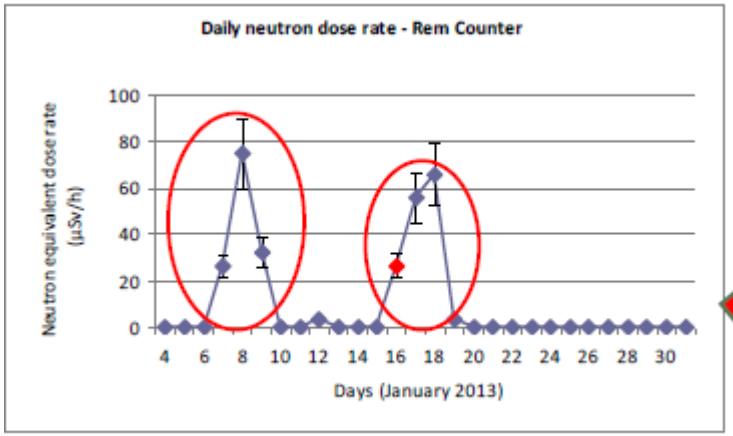
3. **ASI balloon flights**
   Base Trapani Milo, Trapani-Siviglia
   h=38000m,
   36° N

4. **ESA**
   BIOPAN experiment on
   Foton M1 satellite

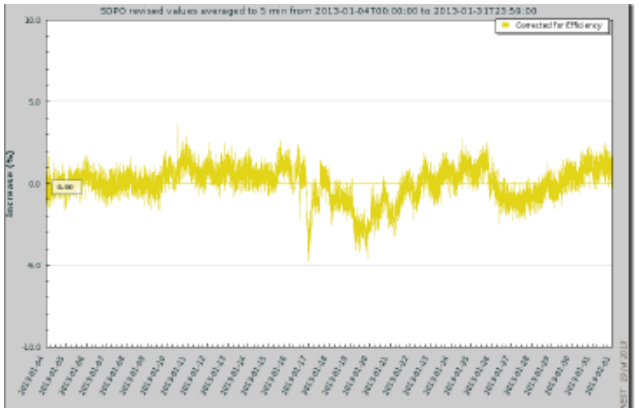


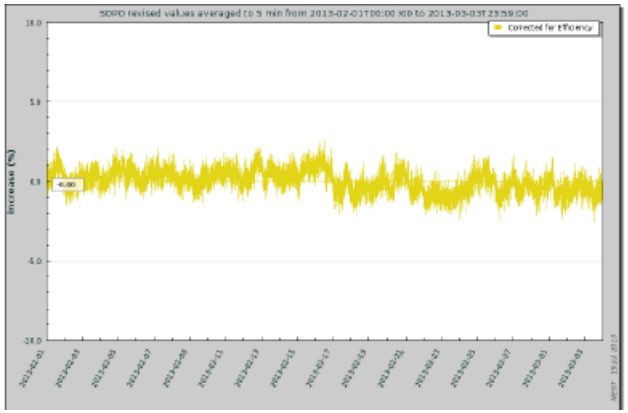
5. **ISS June 2011** BIOKISS experiment

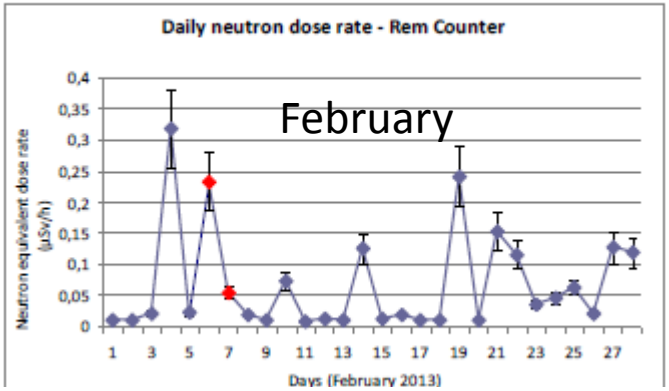
Rem Counter 25 meV-17 MeV



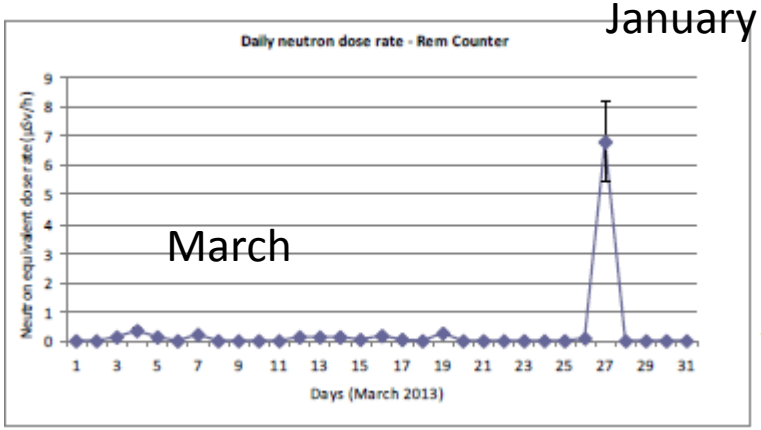
SOPO (South Pole) neutron monitor

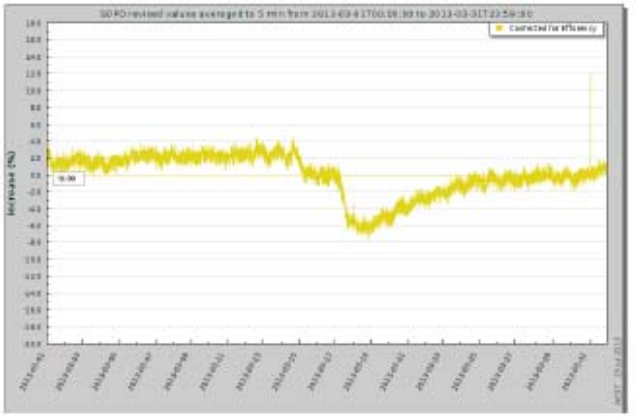






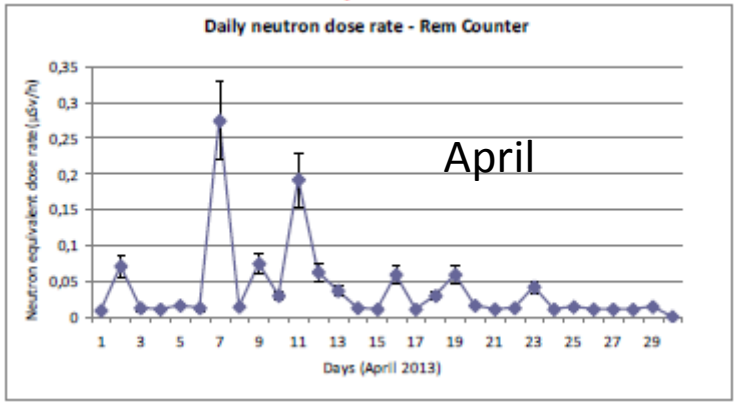
January

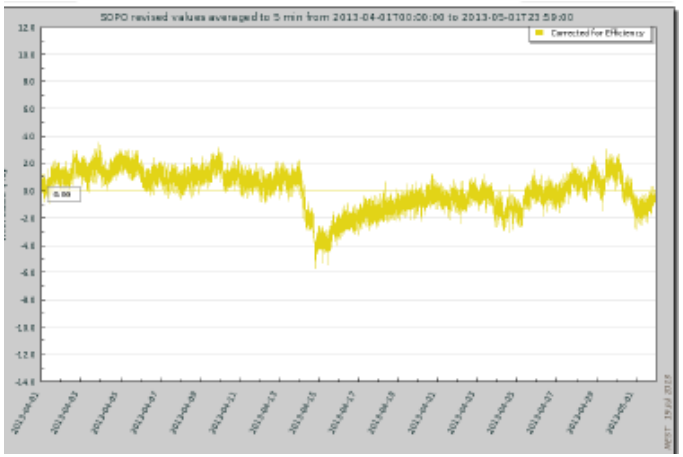


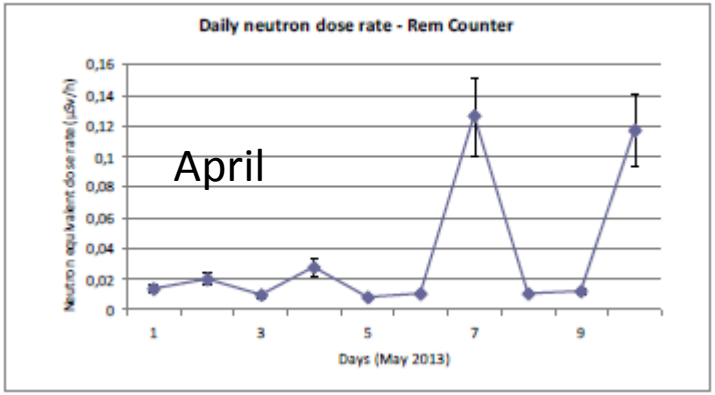


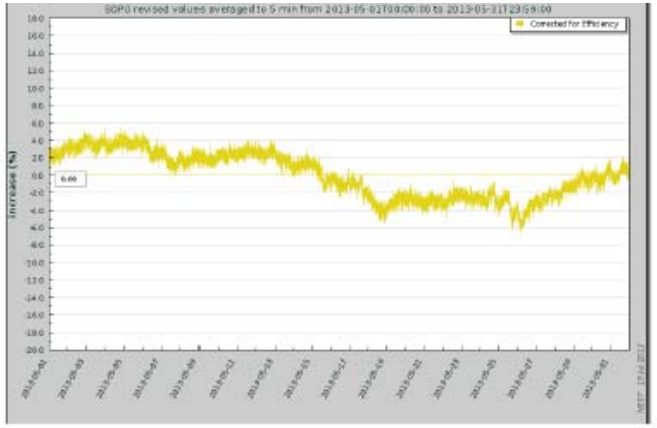
Rem Counter 25 meV-17 MeV

SOPO (South Pole) neutron monitor

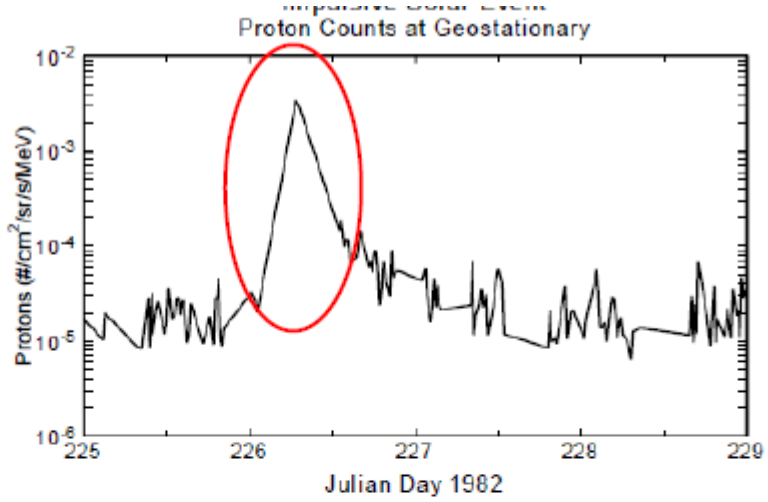


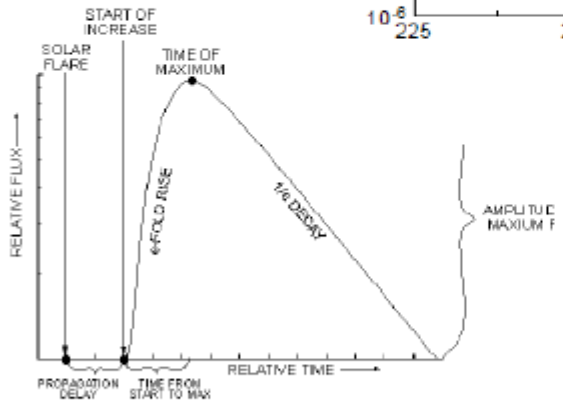






Solar Proton Events





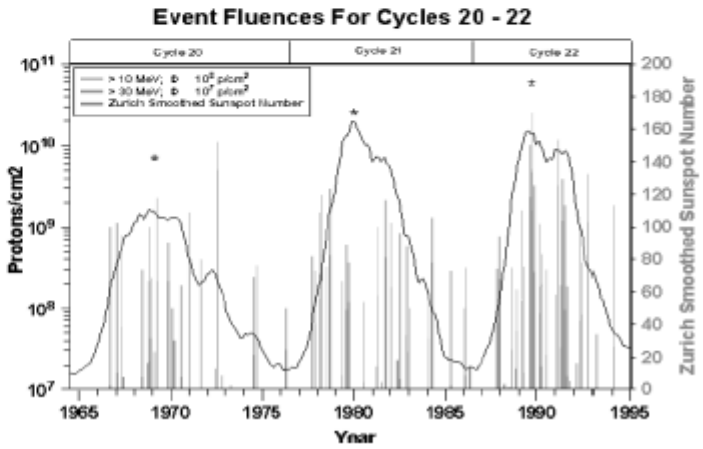


Figure 5.1.6.4: Characteristic solar particle intensity/time s
profile. *Smart and Shea*

Radiation Measurements at Marambio Base (January-May 2013).

Month	(μE.m radiation μGy/h)	Neutrons (μSv/h)	TOTAL (μSv/h)	% E.m radiation	% Neutrons
January	0,077	10,307 peaks (0,358) no peaks	0.436	17,75	82,26
February	0,078	0,111	0,189	39,15	60,85
March	0,080	0,203	0,283	22,09	77,91
April	0,081	0,069	0,150	64,00	46,00
May	0,082	0,050	0,130	59,20	39.80

Table 1. In the table are shown the monthly mean dose rate values recorded by Liulin-I (μGy/h) and Rem-Counter detectors (μSv/h), and the corresponding proportion of the total radiation. % error 20%

Radiation	Energy	H* (μSv/h) mean values Jan-May		H*(mSv/year Annual dose
e.m and charged (LIULIN)	All energies	0,079		0,65
Neutrons (Rem Counter)	0.025 eV-17MeV	0,20		1,75
Neutrons (Bubbles)	0.025 eV-20 MeV	(0,18)		(1,57)
TOTAL				2.40 + -20%

Table 2. In the table are shown the monthly and yearly mean dose rate values recorded by Liulin-I (μGy/h) and Rem-Counter detectors (μSv/h), and the corresponding

Conclusion

The neutron ambient dose equivalent is veri high
Great anisotropy to respect to North Pole data

→ **New investigations are required**

2015 CAMPAIGN

- More Istitutions
- More instruments
- Longer period
- Preliminary intercalibration at Testa Grigia Lab 3480 m asl

NEW PARTICIPANT ISTITUTIONS

- *INFN Sez. Bologna*
- *LNF-INFN Frascati*
- *IASP-INAF Rome*
- *Politecnico di Milano*
- *Istituto Antartico Argentino*

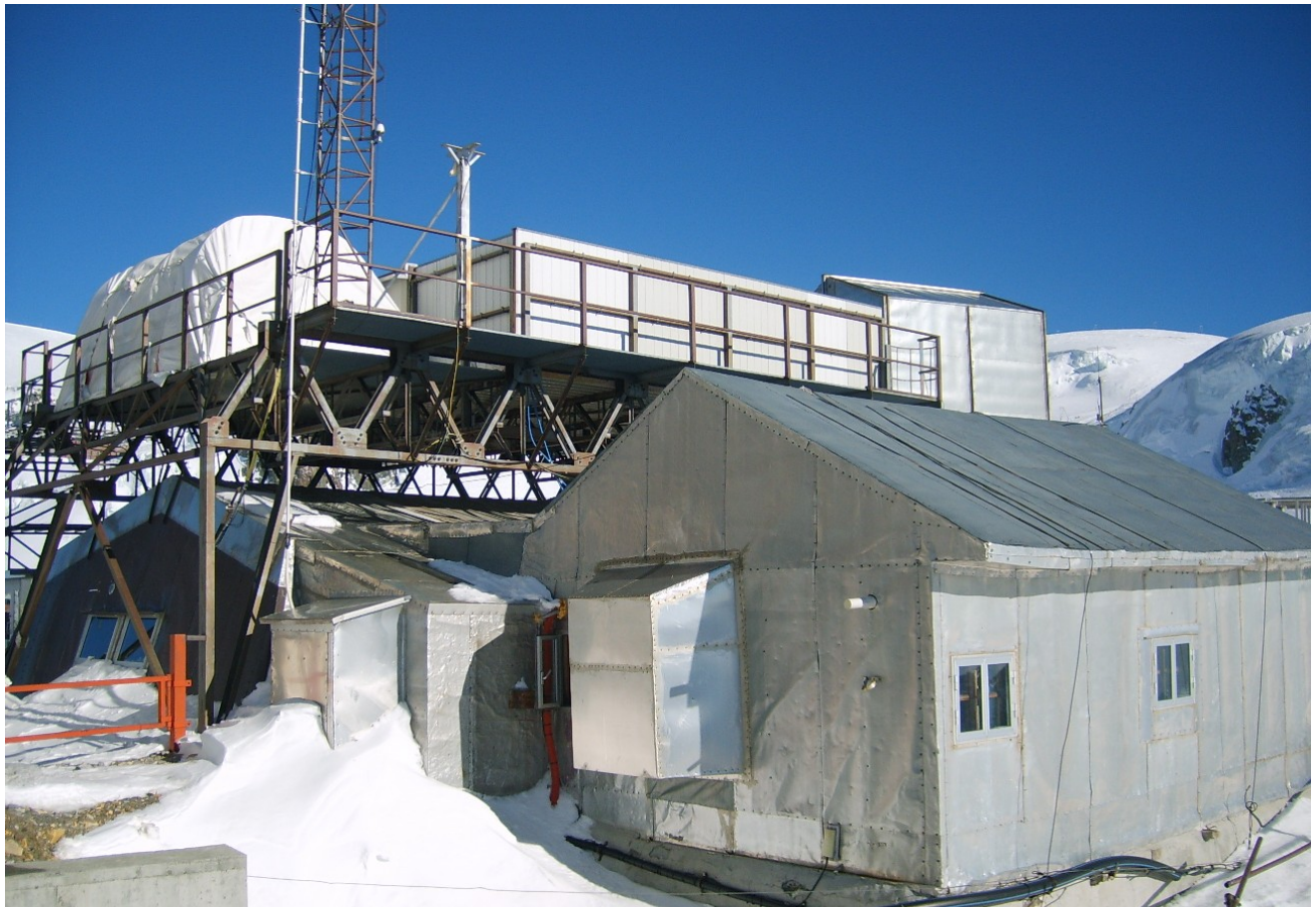
CORA Project **2015 Campaign**

J.C. Terrazas1, P.Diego2, P.Morfino3, A. Liberatore4, A.Esposito5, M.Chiti5, M.Caresana6, M.Laurenza2, A.Zanini7

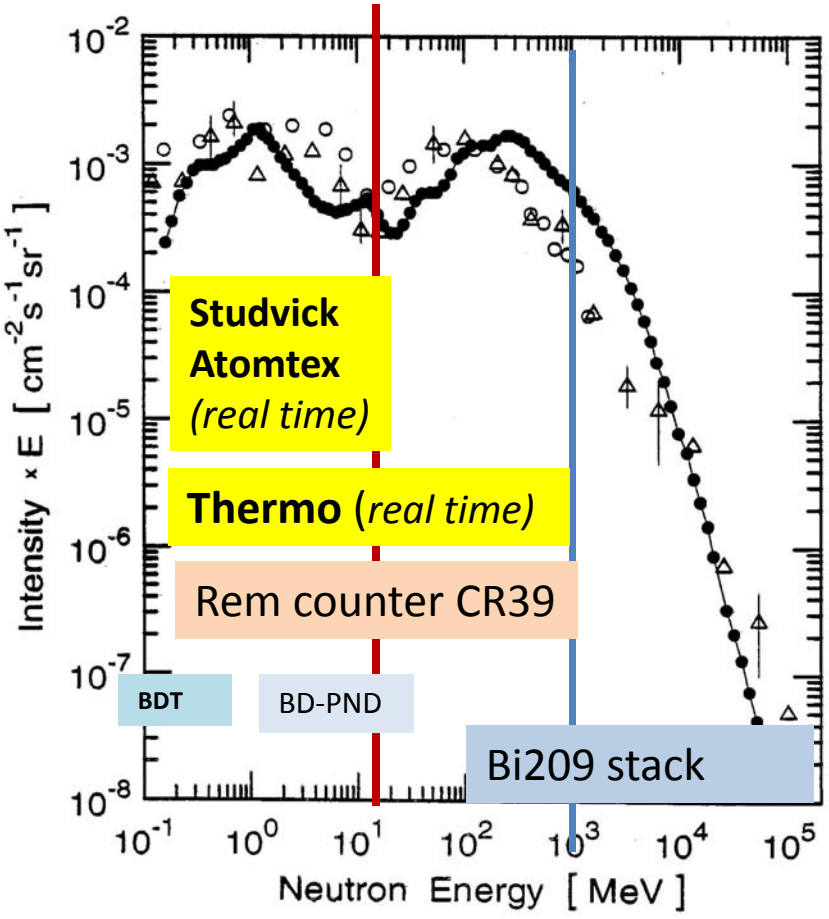
Instrument intercomparison at High Altitude Laboratory

Laboratorio della Testa Grigia
Cervinia, Italy

45° 56' 03" North, 7° 42' 28" East 3480 m a.s.l.



Neutron Spectrum at Plateau Rosa Cervinia 3480 m asl *45° 56' 03" North, 7° 42' 28" East*



Publication: "COSMIC RAYS AT EARTH –Researcher's Reference Manual and Data Book" ELSEVIER SCIENCE (2001).

- Manfredotti et al. (1997), 3500 m (650 g/cm²)
- Merker (1973) 700 g/cm² (~3200 m)
- Schraube et al. (1996), Zugspitze 2963 m

1- Rem Counter Atomtex (INFN Torino)

Energy range — 0.025 eV --14 MeV

- AT1117M works with digital readout consisting of the processing unit (PU1 and/or PU2) with an internal Geiger-Muller counter:
- Energy range: x & γ — from 20 keV up to 3 MeV, ,
- α — 3–7 MeV,
- β — from 155 keV up to 3,5 MeV.

1- Rem Counter Atomtex

2- Extended FHT 762 Thermo (LNF Roma)

Energy Range : 0.025eV - 5GeV

- Linearity: ±20%
- (Angular dependence: ±20% in all directions)
- Sensitivity: Sensitivity: 0.84 cps/(µSv/h) Cf-252
- Gamma sensitivity: 1 to 5µSv/h at 100 mSv/h, 662keV
- Temperature (Metric) Operating -30° to +50°C
- Pressure: 500 to 1500 hPa
- Relative Humidity: up to 90%,

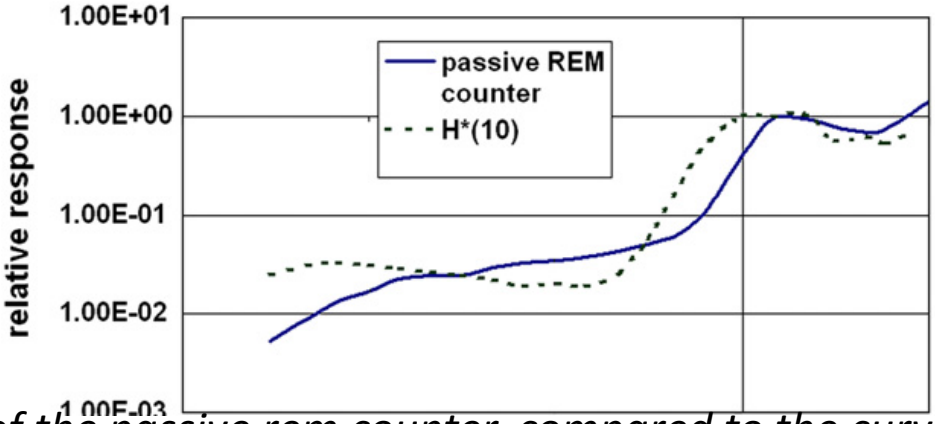
2- Rem Counter Extended FHT 762 Thermo

3- Dual-detector spherical rem-counter
Politecnico di Milano

Energy Range : 0.025eV - 5GeV

- Based on a polythene sphere with lead and cadmium insets, designed to host at its centre either an active (3 detector). Its sensitivity ranges from thermal energies up to 1 GeV.
- The rem counter has been calibrated with a PueBe source.
- The instrument have proved to be capable of measuring the cosmic neutron back- ground.
- The instrument was inter-calibrated with a WENDI FHT672 (in turn calibrated in a secondary standard field), in the neutron field generated by a 5 Ci Pu-Be source at the Politecnico di Milano.
- The calibration factor determined for the passive rem counter is 6.91 ±0.45 tracks/(cm^2 -µSv), while for the active version it is 33 ±16 pSv per count.

3- Dual-detector spherical rem-counter



Response function of the passive rem counter, compared to the curve of ambient dose equivalent, H(10).ICRP 60*

4- Portable Neutron Monitor - INAF Roma

3 NM-64 He3 Portable Neutron Monitor:

The Modular Neutron Monitor (Figure 5) is employed to measure the primary cosmic ray flow variability ; each component of this device was designed in a modular way, so fitting together adifferent number of elements and using different counters it is possible the assembly of a detector with a length varying from 80 cm to 210 cm. Such innovative system allows the realization of a detector equipped with a helium counter type LND 25382 (65 cm) as well as one utilizing a LND 25373 (191 cm) just using a different amount of modules.

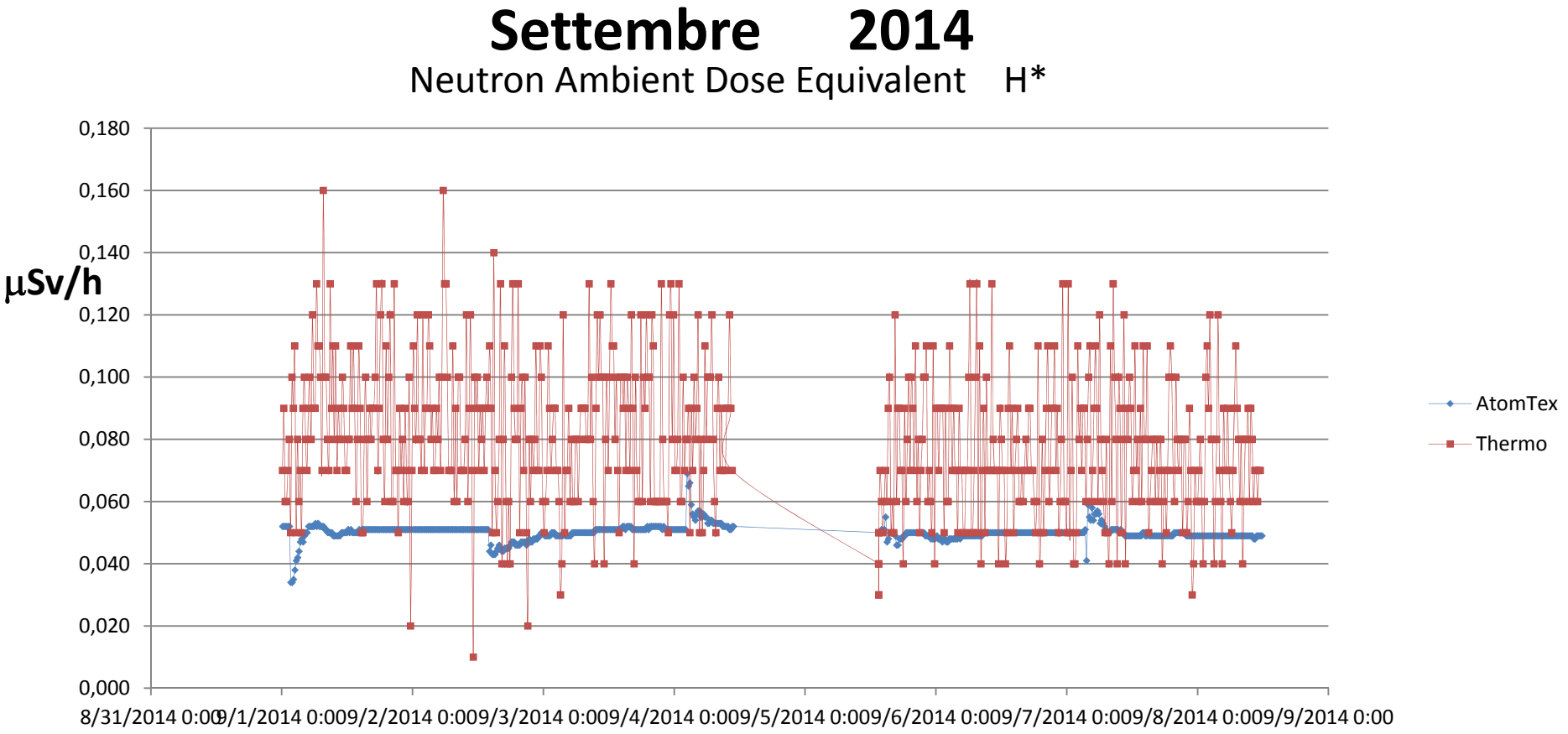
Functional and comparative tests of the mobile neutron monitor have been performed at SVIRCO Observatory & TPL in Rome. The modular unit unit has been calibrated against the standard 20NM-64 detector of the Observatory.

Connections of the NMD

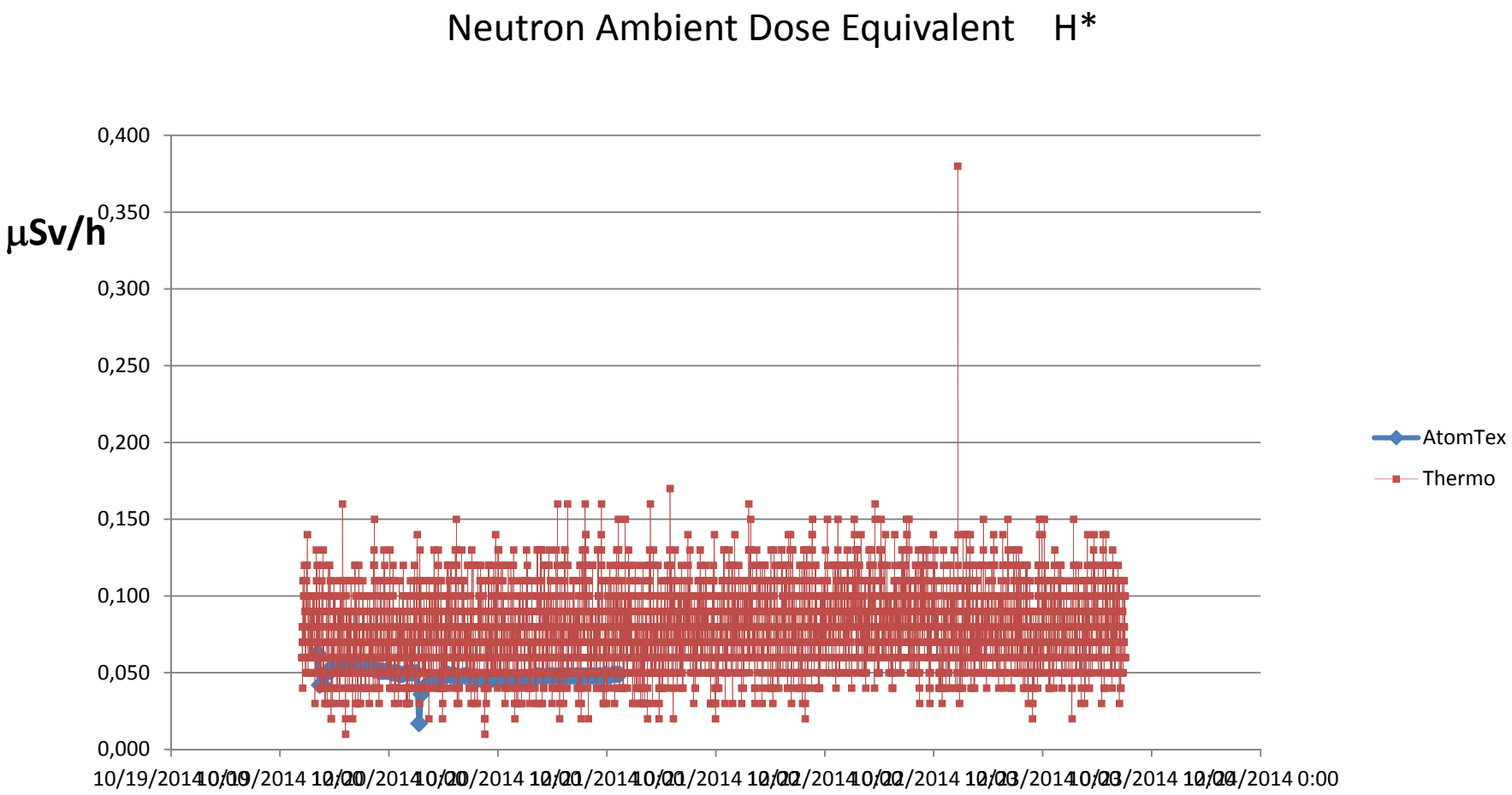
Neutron Monitor

Instruments inside Testa Grigia Laboratory

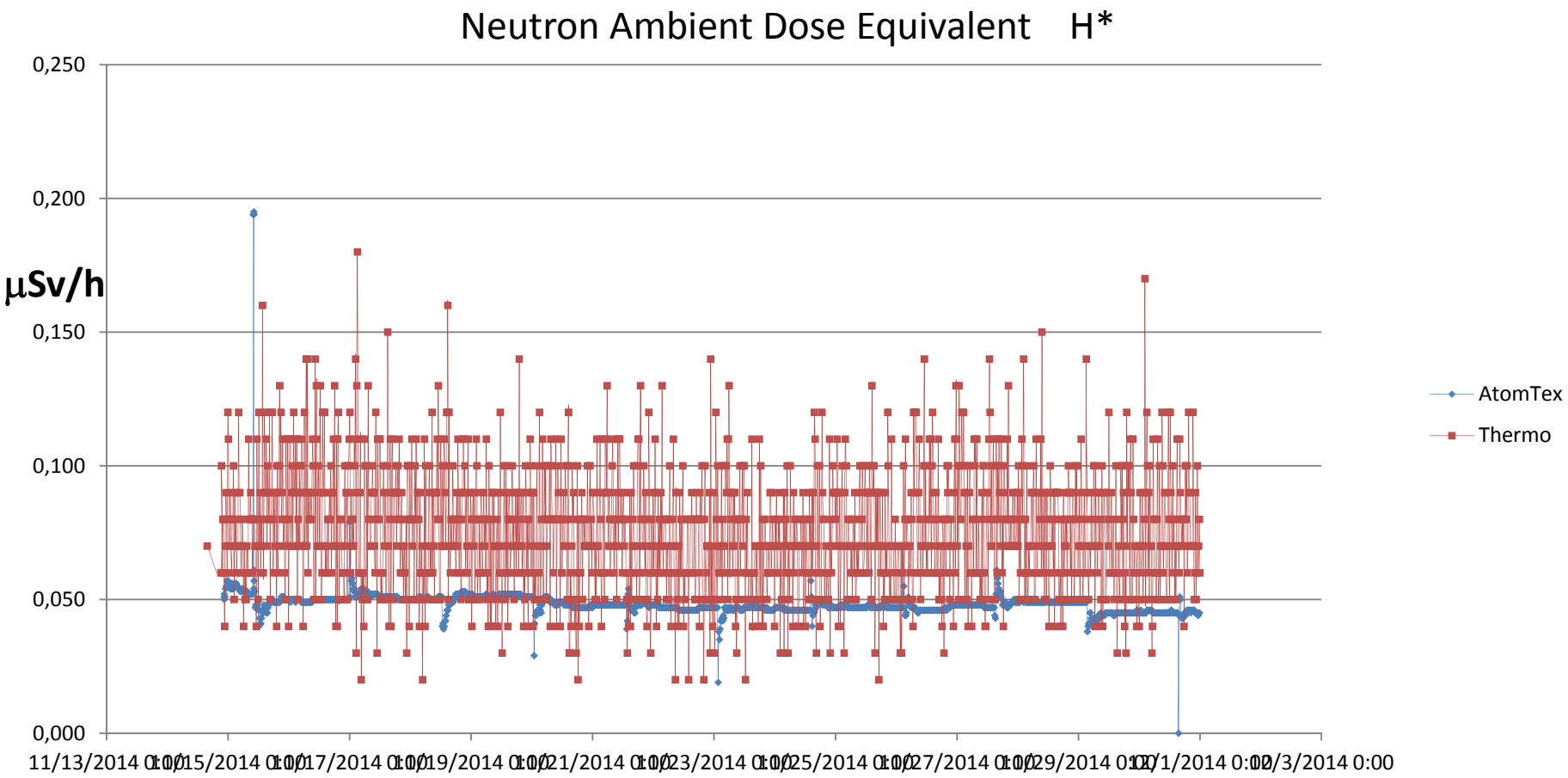
THERMO (*0.025 eV-5 GeV*) vs. ATOMTEX (*0.025 eV- 17 MeV*)



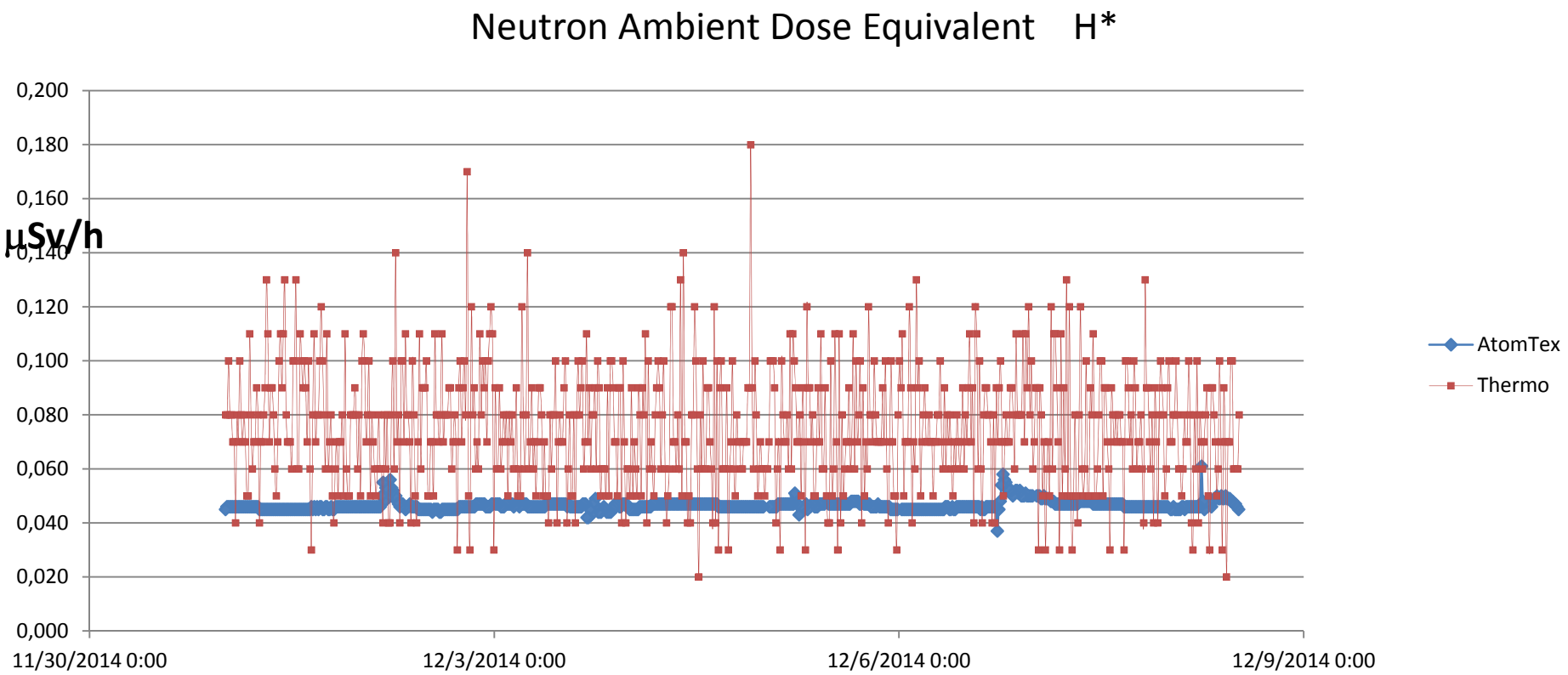
Ottobre 2014



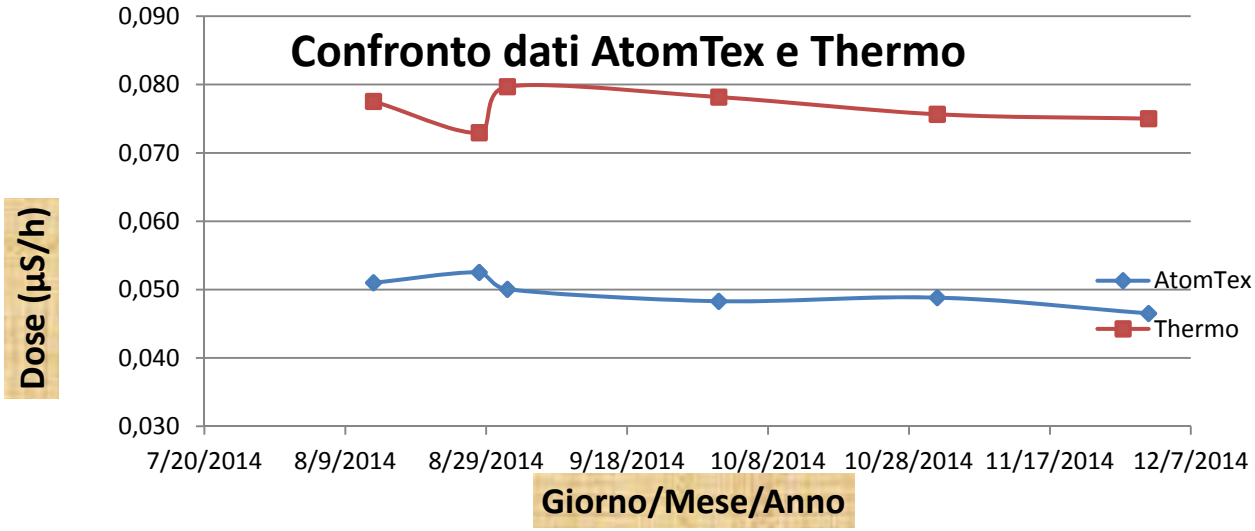
Novembre 2014



Dicembre 2014

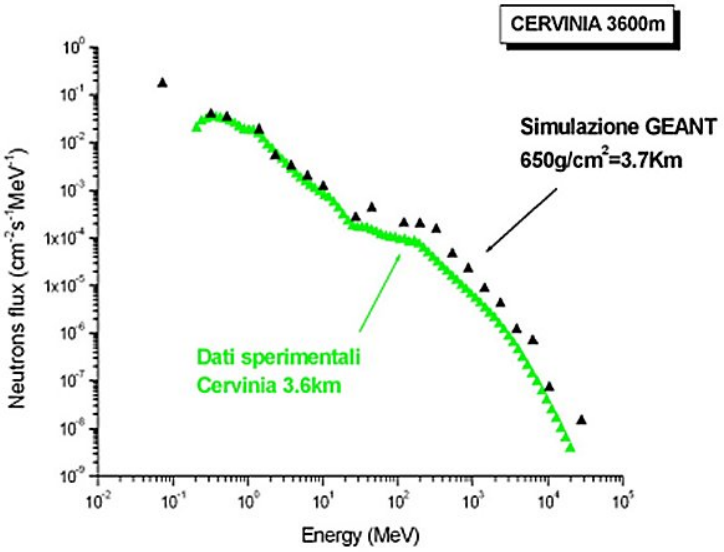


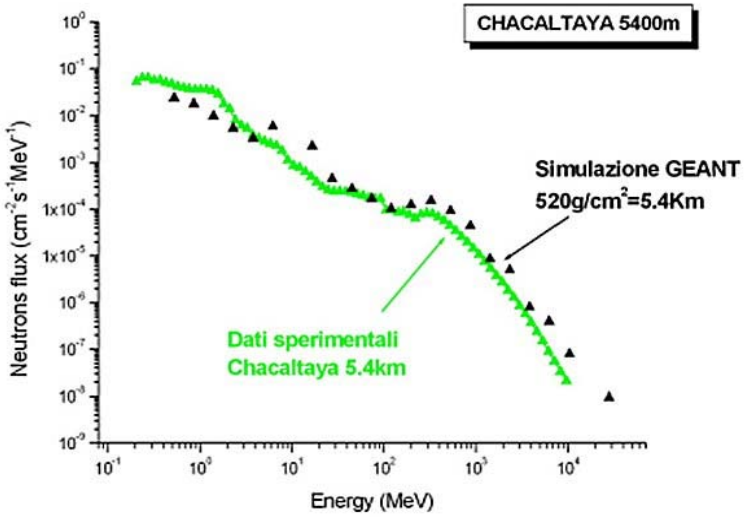
Cervinia Confronto Thermo vs. Atomtex
Agosto-Dicembre 2014



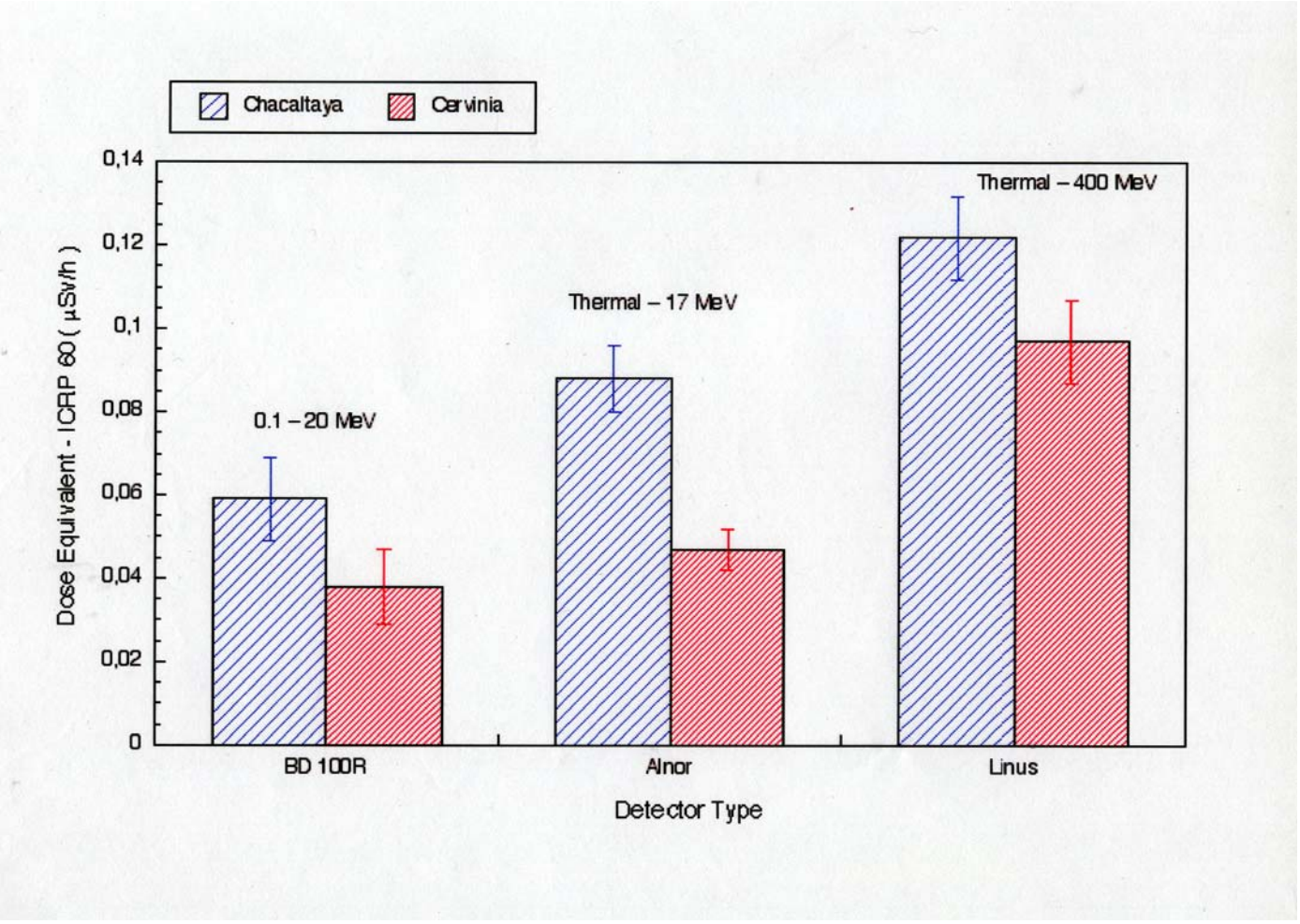
Mese	Atomtex H* (µSv/h)	Thermo H* (µSv/h)
Agosto I Agosto II	0.051 0.001 0.050 0.001	0.075 0.003 0.073 0.002
Settembre	0.050 0.003	0.079 0.023
Ottobre	0.048 0.004	0.078 0.023
Novembre	0.049 0.01	0.075 0.002
Dicembre	0.047 0.001	0.075 0.002

Comparison Cervinia Chakaltaya





Comparison Cervinia Chakaltaya



H* µSv/h

Plateau Rosa, Cervinia
3600 m asl 1998

Studvick
(0.025 eV< En<20 MeV)

Linus (0.025 eV< En<400 MeV)

CORA Project 2015 Campaign

J.C. Terrazas1, P.Diego2, P.Morfino3, A. Liberatore4, A.Esposito5, M.Chiti5, M.Caresana6, M.Laurenza2, A.Zanini7

1° of March 2015 - November 2015

Instrument exposure at Argentine Antarctic Marambio Base

74° 13’ S 54° 43’ W

Arrival at the base

Researchers carrying the equipment

The Hercules of Fuerza Aerea Argentina

Marambio people

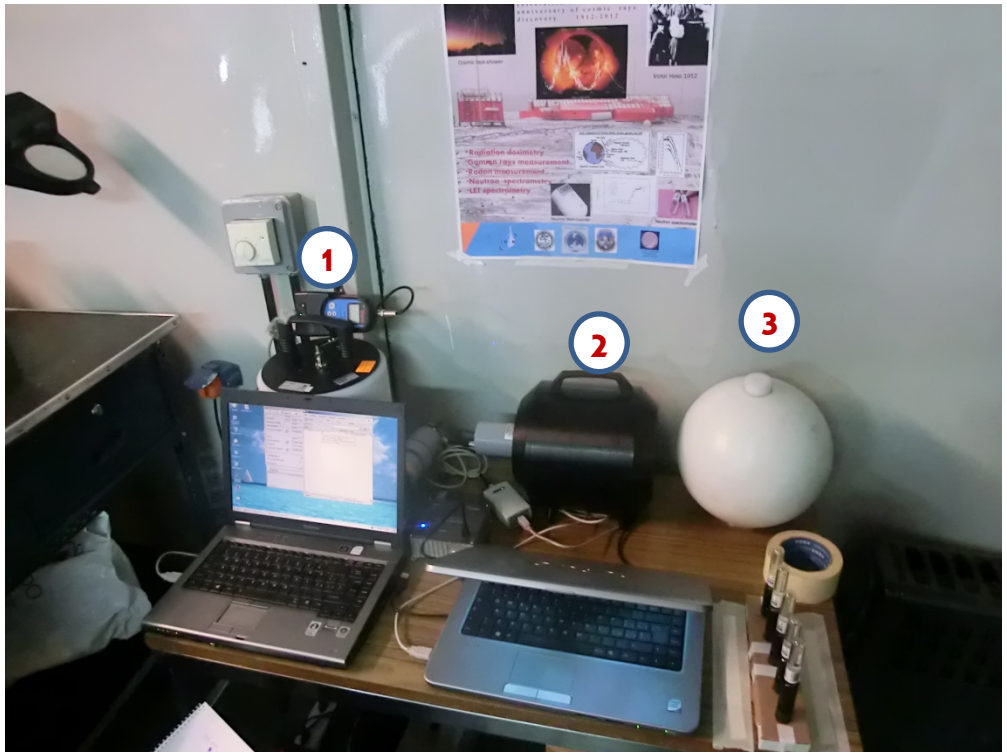

"CORA PROJECT 2013 "
ARGENTINEAN ANTARCTIC MARAMBIO BASE.
Gustav
Paolo
Vincent

Instruments Marambio 2015 Campaign

Detector	Application	Energy Range	Institution
ACTIVE DETECTORS			
1- Atomtex	***Neutrons***	*25 meV-14MeV*	INFN Torino
2- Studvick 222	***Neutrons***	*(25 meV-17MeV*	INFN Torino
3-Thermo	***Neutrons***	*25 meV- 5 GeV*	LNF Frascati
4 -Liulin 4	***Low LET radiation***	*all energies*	INFN Torino
ACTIVE DETECTORS			
5-CR39 SSNTD	***Neutrons***	*25 meV- 1 GeV*	PoliMi
6 -Bi209 Stack	***Neutrons***	*50 MeV- 100 GeV*	INFN Torino
7- CR39	**Neutrons**	*10 keV-20MeV*	LNF Frascati
8 -BDT (Bubble)	**Neutrons**	*25 meV- 4 eV*	INFN Torino
9 - BD-PND	**Neutrons**	*100 keV - 20 MeV)*	INFN Torino
10-BDKG – 04	x+ γ ***radiation***	*15 keV-3 MeV)*	INFN Torino

Marambio base -Neutron dosimetry-2015 campaign

Active Detectors



From left to right *1 -THERMO,*
2- ATOMTEX,
3- REM COUNTER CR39

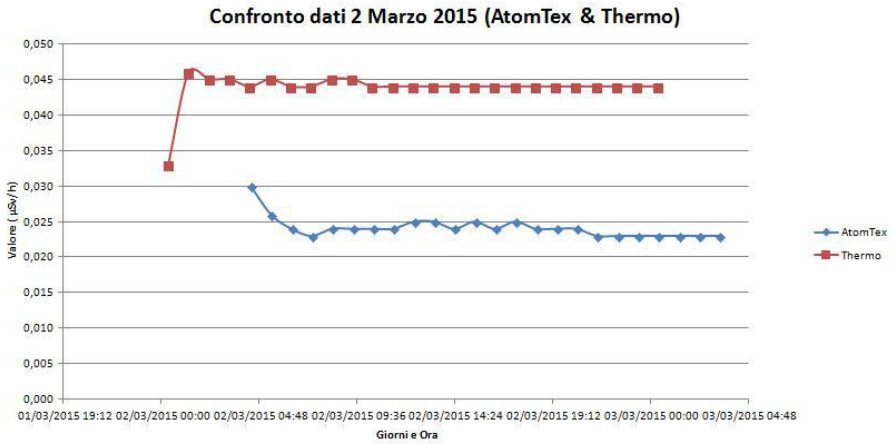
Passive Detectors

4-Bi209 stack *5- CR39*

6- BDT *7-BDPND*

Paolo Morfino and Helios Fernadez at Marambio Laboratory testing the instrumentation

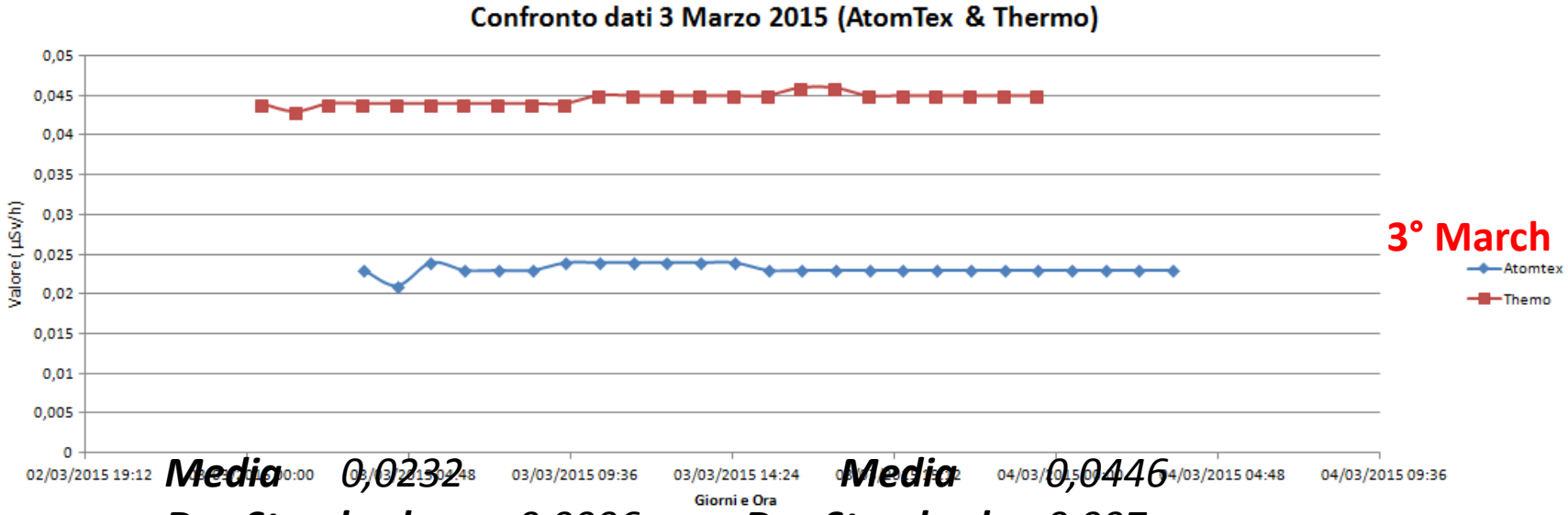
Comparison THERMO vs. ATOMTEX



2° March

Media *0,0242*
Dev.Standard *0,002*

Media *0,044*
Dev.Standard *0,0015*



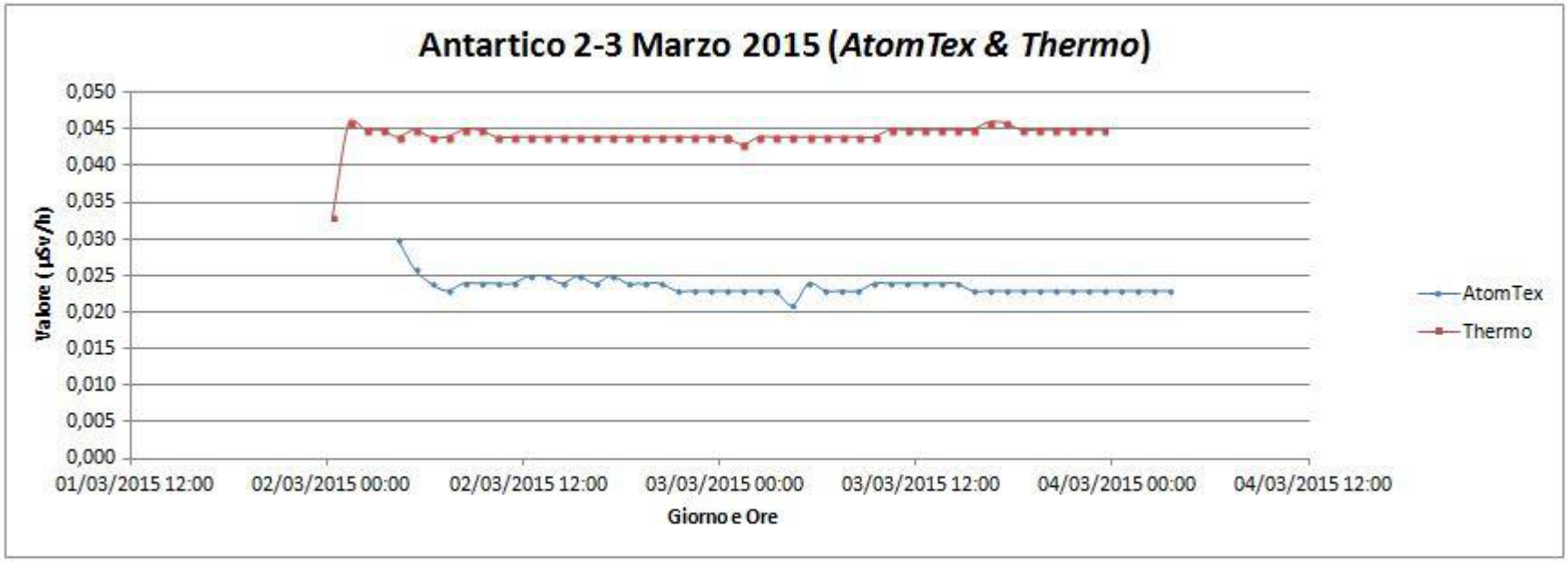
3° March

Media *0,0232*
Dev.Standard *0,0006*

Media *0,0446*
Dev.Standard *0,007*

Comparison THERMO vs. ATOMTEX

TUTTI I DATI DI MARZO 2015 :



AtomTex	
Media	0,0237
Dev.Standard	0,0012

Thermo	
Media	0,044
Dev.Standard	0,002

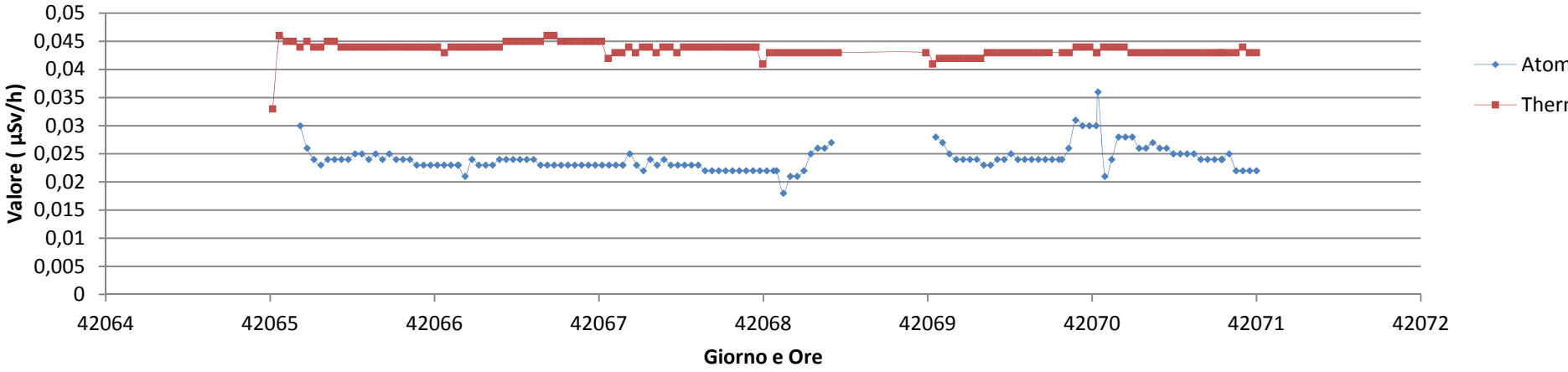
Atomtex µSV/h 0.024

Thermo µSV/h 0.044

Comparison THERMO vs. ATOMTEX vs. Bubble detectors

Neutron Ambient Dose Equivalent

Antartico Marzo 2015 (*AtomTex & Thermo*)

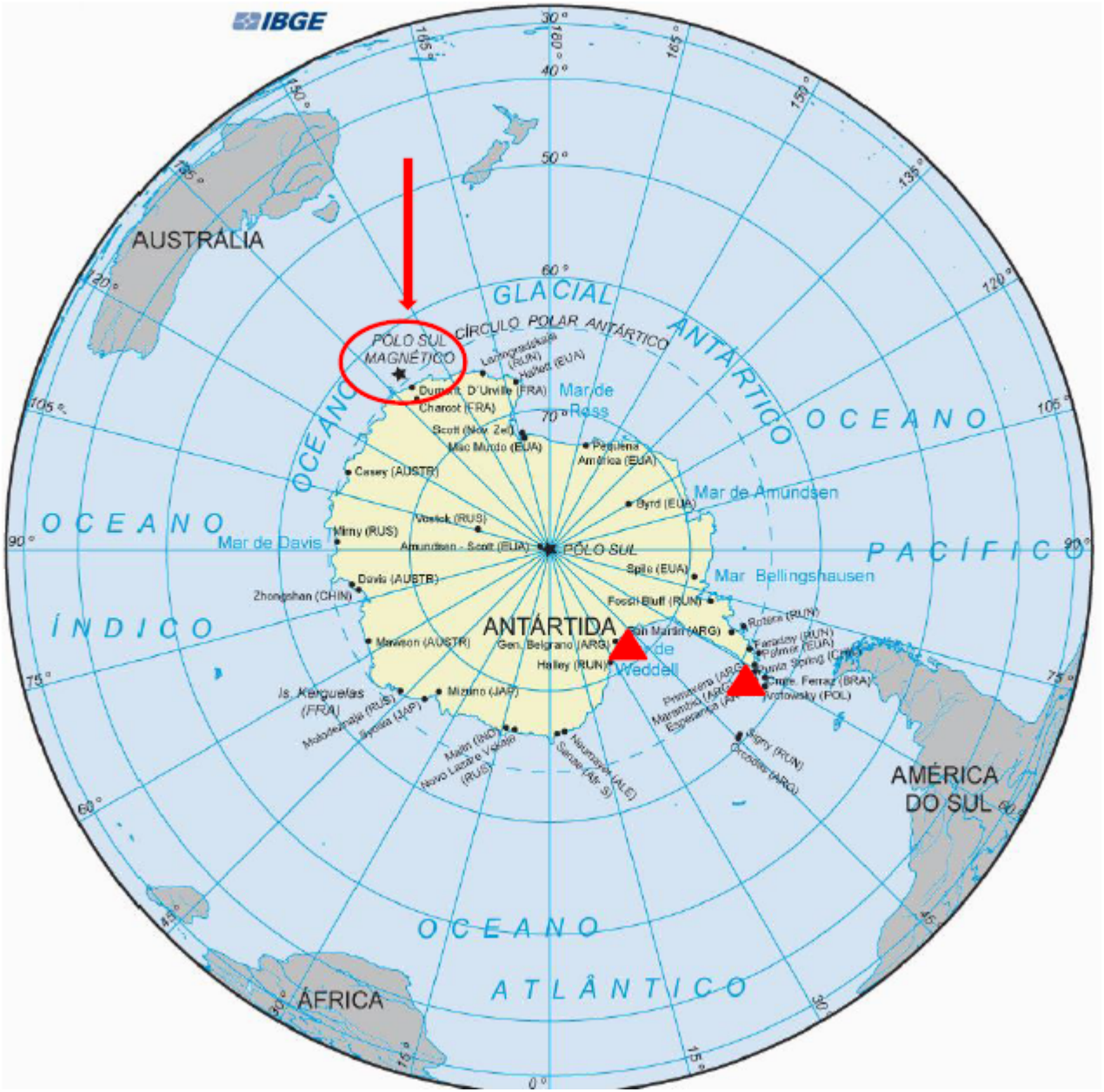


							BDT	BDPND	Tot
	AtomTex			Thermo					
	Media		0,0241	Media		0,044	0.008	0.022	0.030
	Dev.Standard		0,0022	Dev.Standard		0,001	0.002	0.006	0.01

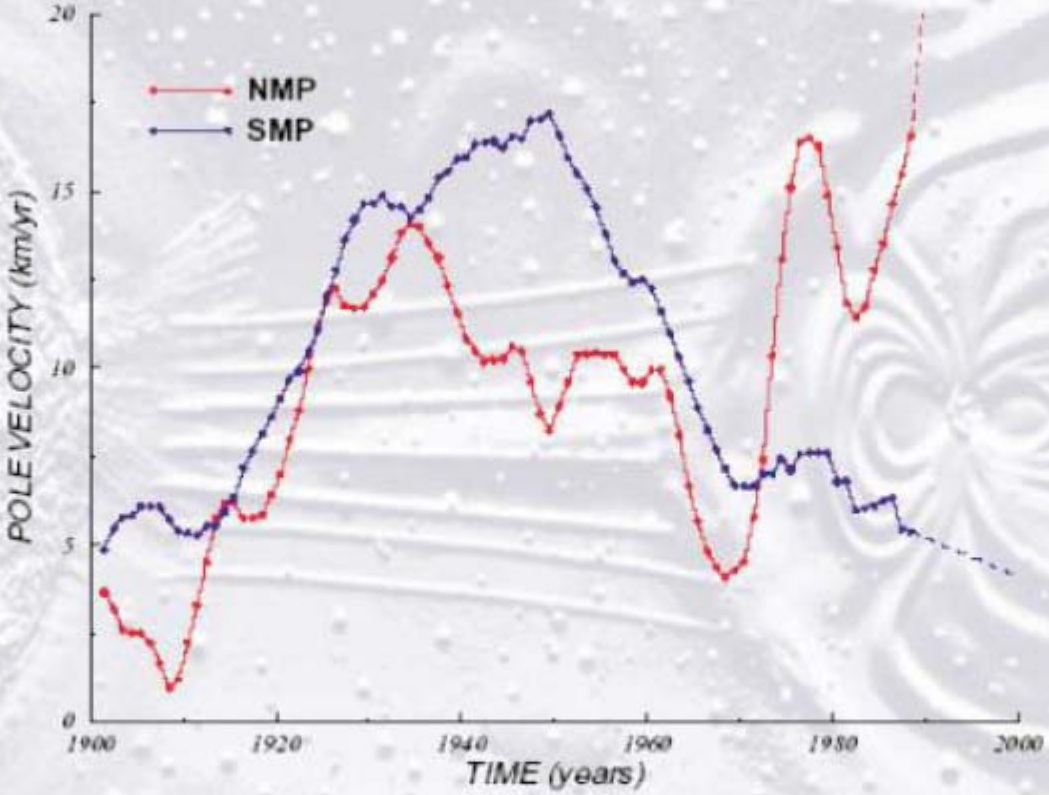
Comparison South Pole vs. North Pole

	H* (μSv/h)	Energy Range	Detector
• Marambio 64° 13’ S 56°43’W	**0.043**	25 meV <En< 1 GeV	Thermo
• Spitzbergen 64° 13’ S 56°43’W	**0.008 7** +- 0.0006 μSv/h	25 meV <En< 1 GeV	Bonner Spheres

South Pole Deplacement



GEOMAGNETIC FIELD ROLE - 3



Mandea & Dormy, Asymmetric of magnetic dip poles, Earth Planets Space 55, 153-157, 2003

Open Questions and Future Work

1-Environmental Exposure

- Antarctic locations closer to magnetic South Pole are exposed at higher environmental radiation
- The bases on the Antarctic Plateau (Dome C, Mc Murdo, Scott Amundsen) at 3000 m asl could overcome the admitted exposure limits (1 mSv/y)
- Further investigations are required, to evaluate if the working people have to be considered professionally exposed (as pilots or astronauts)
- New campaignes are planned at Belgrano (Argentine) and at DomeC (French-Italian)
- The antropomorphic phantom Jimmy will be employed, to evaluate the neutron dose to human body

2-South –North anisotropy

- The values of H* measured at North Pole are very lower thn the measured at Marambio base
- Further investigations are required to understand this anisotropy (excluding instruments failure)
- Possible variation in geomagnetic and solar magnetic fields?

3- Correlation between solar activity and netron ambient dose equivalent

- It is possible to correlate solar activity and neutron ambient dose equivalent?
- A portable neutron monitor (IASP-INAF) will be installed at Marambio base to compare primary cosmica rays variability with neutron dose collanboration will be established with CONAE to install neutron detectors on board of Aquario satellite.

ACCORDO DI COLLABORAZIONE SCIENTIFICA

tra le seguenti Istituzioni Italiane e Argentine

L'ISTITUTO NAZIONALE DI FISICA NUCLEARE
INFN Sezione di Torino (Italia)
INFN Sezione di Bologna (Italia)
LNF-Laboratori Nazionali di Frascati (Italia)

L' ISTITUTO DI ASTROFISICA SPAZIALE E PLANETOLOGIA
IASP-INAF (Italia)

L'UNIVERSITA' NAZIONALE DI LA PLATA
UNLP (Argentina)

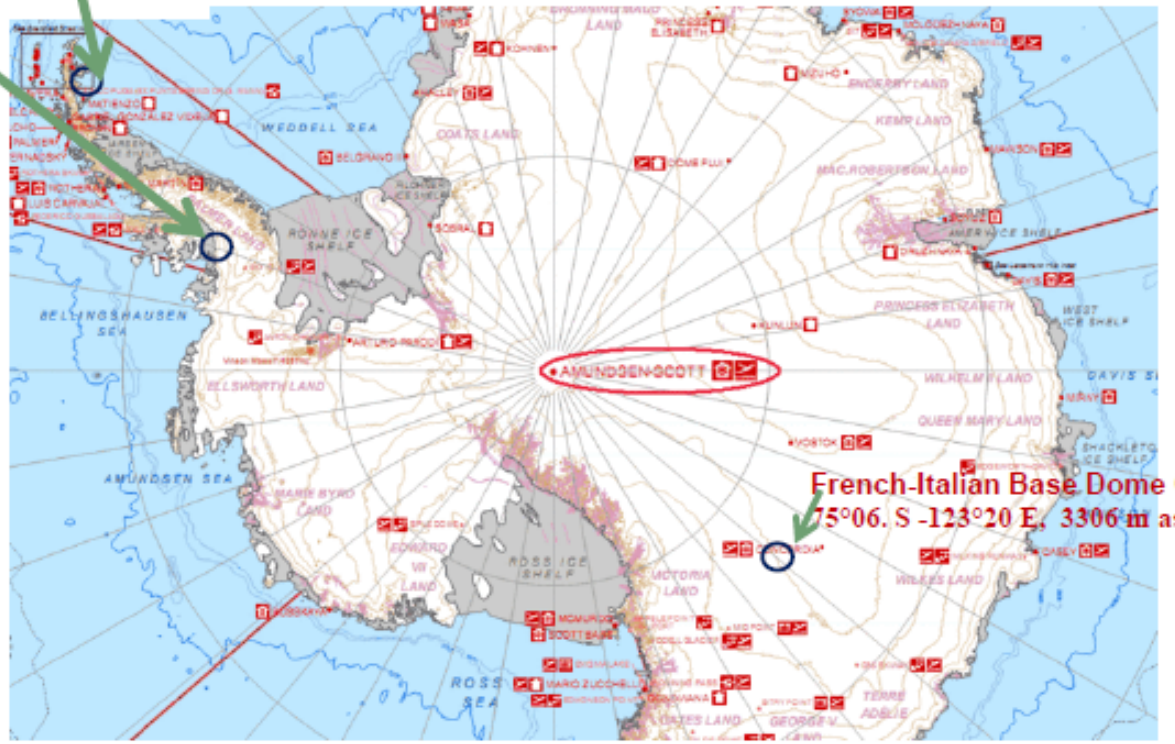
L'ISTITUTO ANTARTICO ARGENTINO
IAA (Argentina)

Con il Direttore del CONAE _
Comision National de Actividad Spatial Ing Varotto

Con il Direttore del IAA
Istituto Antartico Argentino
Ing Conti

Marambio Base
(64° 13'S –56°43'W)
GV 0.22

Belgrano Base
(77°52′ S- 34°37′ W)
GV 0.86



French-Italian Base Dome C
75°06. S -123°20 E, 3306 m asl.

ANNUAL ANTARCTIC CONTINGENT

Since workers are known to be exposed to High LET radiation, a CYTOGENETIC STUDY is going to be performed before and after the Current 2013 Antarctic Campagne .

Personal Dosimeters will be wore by the workers, in order to daily monitor their personal exposure

Biological studies

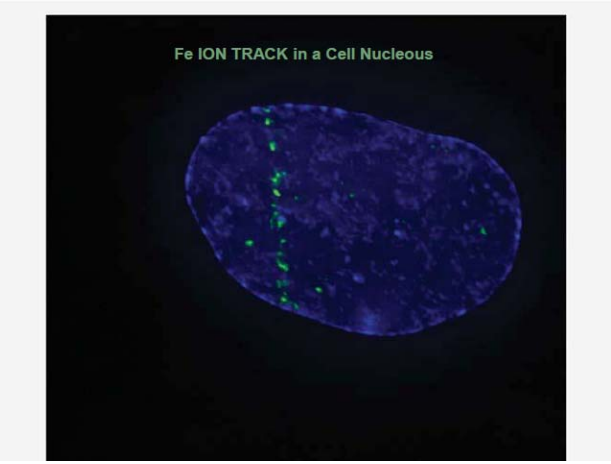
Prof. Vicente Ciancio

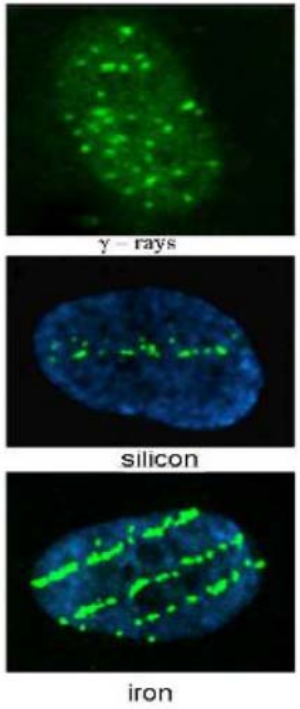
Space Medicine Department, La Plata University, Argentina

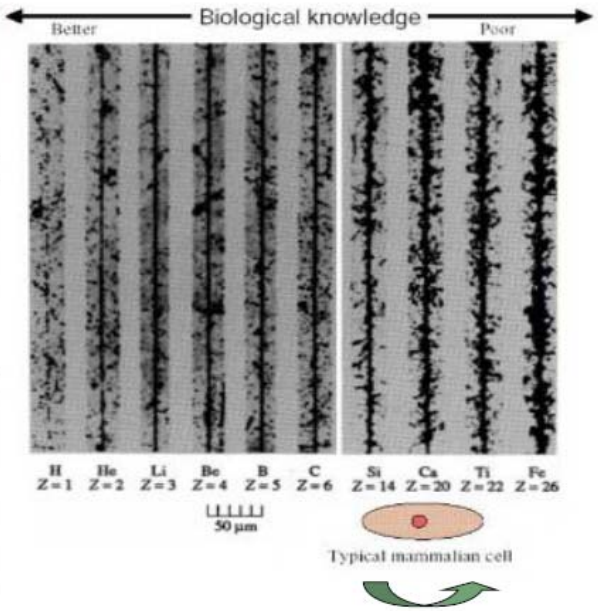
- Effects of cosmic rays (and the track through the Nucleous of human Cells) on the GENOME target : ADN macromolecule, Inducing Chromosomal Damage (Aberrations) as we could see in the microphotografy refered as Rings, Dicentrics, Fragments, etc.
- These alterations are produced inclusive with the Low Dose Rate that is permited by the current ICRP recommendations and these slides showed our study on Argentina´s FLight attendants.
- Prof. V. Rafnson demostrate an increase 50 % superior of Breast and Skin Cancer in Scandinavean Flight Att. when compared with controls.
- Actually there are more advanced studies to detect specific GENES that are expressed when the ADN are damaged that are denominated BIOMARKERS .
- In this sense, we presented in the Aerospace Medical Ass. Meeting in Chicago may 2013, the firstly and unique study in the World, performed on 70 Argentinean Flight Att. in wich we demostrated their effectivity throught their Up-Regulation, Down-regulation and/or Repression.
- The great sensitivity of this technique are recommended by recognized Institutions and the necesary research to know the real consecuence of LOW Dose radiation in specific organs as are the LENS of the Eye and Brain , etc.

Biological Study

Space Medicine Department Università di La Plata







Thank you for your attention

CORA PROJECT

COSMIC RAYS IN ANTARCTIC

Universitad National de La Plata

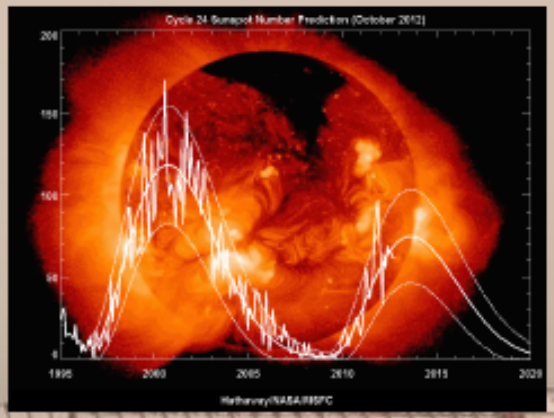
Università di Torino Istituto Nazionale di Fisica Nucleare Sez.Torino

Ecole Internationale d' Astrophysique Daniel Chalonge

2015 CAMPAIGN

Cosmic rays measurement campaign at **Marambio Base** in the framework of celebration for the 100° anniversary of cosmic rays discovery **1912-2012**

Cosmic rays shower



Victor Hess 1912