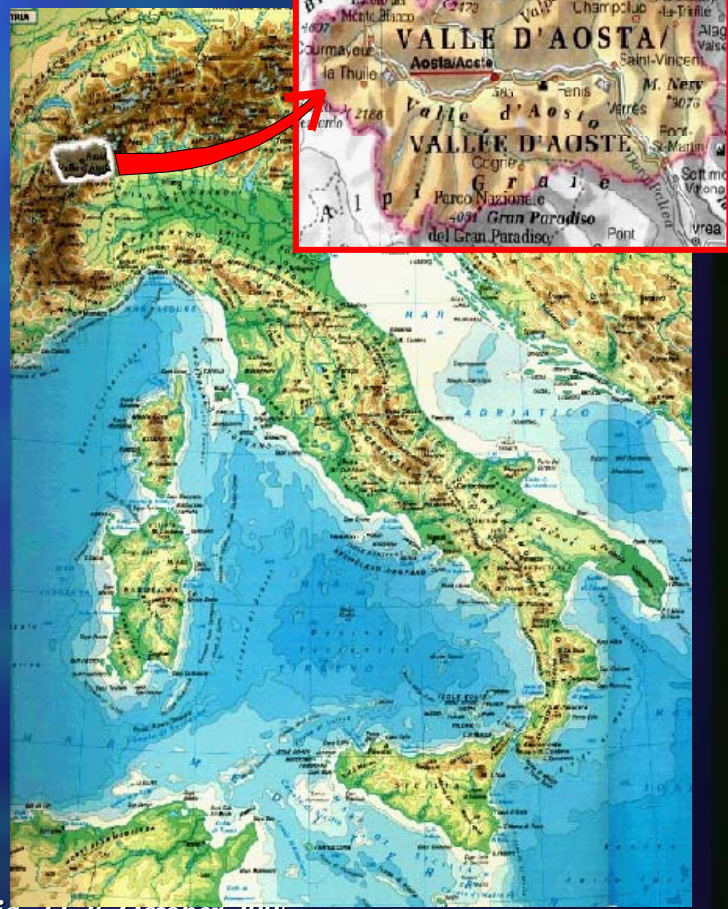
RESEARCH ACTIVITY AT TESTA GRIGIA LABORATORY

Alba Zanini, INFN – Istituto Nazionale di Fisica Nucleare - Torino

TESTA GRIGIA LABORATORY

Features *Caratteristiche*	
Geographic latitude	45°56'03'' N
Geographic longitude	7°42'28'' E
Atitude	3480 m 630 gr/cm^2
Laboratory	66 m^2
Cupola	16 m^2
External Platform	110 m^2
Liveable area	30 m^2


VALLE D'AOSTA
Aosta/Aoste
VALLÉE D'AOSTE
Parco Nazionale
del Gran Paradiso

TESTA GRIGIA LABORATORY

Testa Grigia Laboratory is located in a wide upland, surrounded by glaciers of some of the highest peacks of Europe, in the north of the wonderful Valtournenche (AO) in Italy, at the feet of Matterhorn, near Testa Grigia Peack in the border between Italy and Switzerland.

Edoardo Amaldi, Gilberto Bernardini and Ettore Pancini at the Testa Grigia Laboratory (1947)

The Testa Grigia Laboratory was built in 1947 by the Study Center for Nuclear Physics of CNR (National Council of Research). On behalf of the Institute of Physics in Rome, headed by Edoardo Amaldi, the project and realization were due to Gilberto Bernardini, Claudio Longo and Ettore Pancini.

RESEARCH AT TESTA GRIGIA LABORATORY

§**Cosmic ray. Seeking diffuse gamma-ray background radiation (GRBs)**

IFSI-Sezione di Torino, Università di Torino

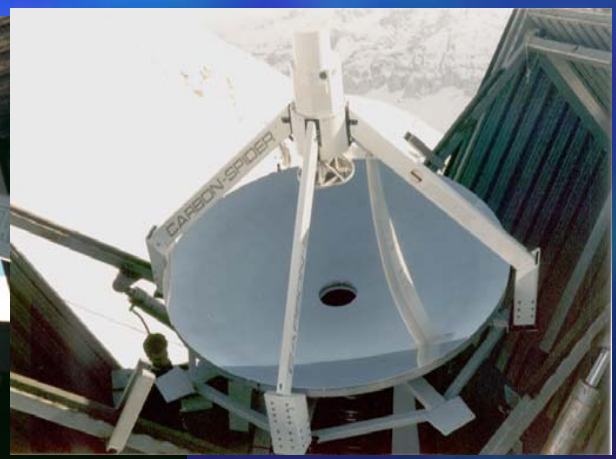
The aim of the experiment is to search for the high energy (10 –100 GeV) counterpart of cosmic GRBs observed by satellite experiments in the KeV–MeV energy region. The detection or upper limits on GRBs of this energy would give information on the distance of the GRB sources by exploiting the gamma ray absorption by the infrared photons in the intergalactic space.

RESEARCH AT TESTA GRIGIA LABORATORY

§ **Ground-Based Telescope** for mm-Infrared Observations (MITO)

Università di Roma "La Sapienza"

Scientific goal of MITO (Millimeter and IR Testa GrigiaObservatory) project is the polarization measure of ground cosmic radiation radiation at 3 °K



A. Zanini - zanini@to.infn.it - BEOBAL Workshop, Bulgaria, 22-26 C

RESEARCH AT TESTA GRIGIA LABORATORY

§ **Radio-acoustic measurement of the temperature profile in the Troposphere**

Dipartimento di Fisica Generale, Università di Torino and Istituto di Cosmogeofisica, CNR, Torino

This system can operate authomatically and unattended, giving a good precision (~ 0.5 °C) and vertical resolution (~ 30 m) for an average thermal profile in Troposphere which can be obtained every few minutes. The tecnique uses a Doppler tracking of an acoustic pulse by a continuous wave radar. The system consists, in its essence, of a powerful acoustic generator beaming toward the zenith a short train of sinusoidal waves. The speed of this signal during its rise depends on the square root of the local absolute virtual temperature. This speed is continuously measured from the ground by means of a Doppler radar. The radar echo is due to the change in the refraction index of air, caused by the pressure of the acoustic wave.

RESEARCH AT TESTA GRIGIA LABORATORY

§ Greenhouse Gases Monitoring

CESI, Università di Torino, IFSI-Sezione di Torino

Because of its elevation and position, far from urban and polluted zones, the Testa Grigia Station has been considered suitable for being included in the world wide network (WMO - World Meteorological Organization) devoted to the monitoring of green house gases concentration.

CO_2	since 1989
CFC11-12	since 1991
CH_4	ince 1991
$CFCCl_3$, CF_2Cl_2	since 1989
N_2O	since 1992
SF_6	Snce 2001

Activities of INFN group at Testa Grigia Laboratory

- ✓ Neutron spectrometry using passive detectors
- ✓ Optimization of Monte Carlo simulation codes (Geant3, Geant4, FLUKA)
- ✓ Gamma scectrometry using NaI detector
- ✓ Detection of secondary charged particles (scintillator detector)

Neutron spectrometry using passive detectors

An accurate evaluation of the neutron energy spectra in atmosphere requires:

- **a wide energy range detection system;**
- **reduced size and no electronic supply in such experimental set-up like intercontinental flights.**

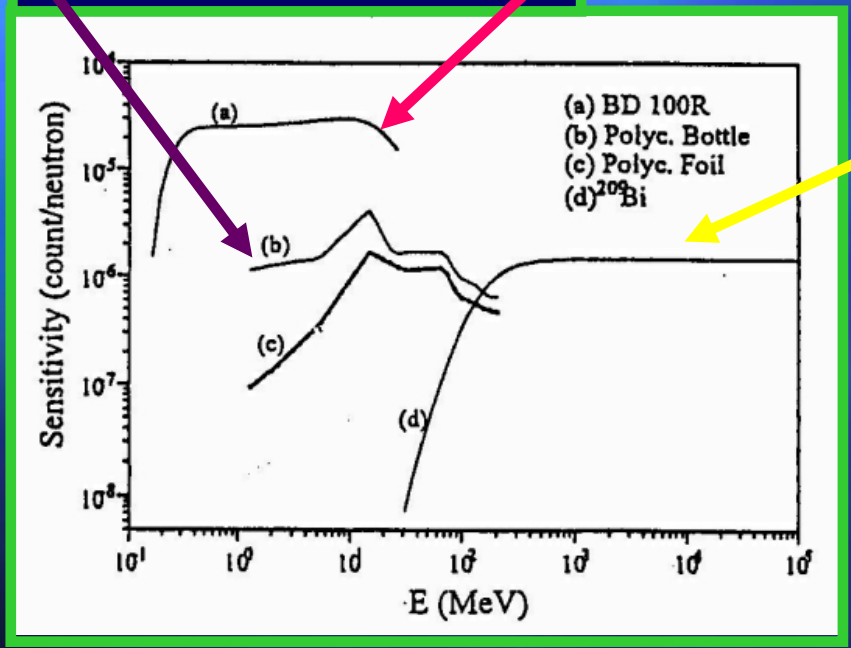
1. The extended energy range system (100 keV - 100 GeV)

1. Bubble dosemeter BD100R	**100 keV- 20MeV**	Polycarbonate vials filled by tissue equivalent gel, in which microdroplets of superheated freon are spread. Charged recoil particles, produced by the interaction of neutron with gel, give raise to visible bubbles.
2. Polycarbonate detectors foil **3. Polycarbonate detector bottles**	**1 MeV- 100 MeV**	Track are left by recoil products, generated by neutron interaction and revealed by etching tecniques.
4. Fission detector ^{209}Bi	**100 MeV- 100 GeV**	Stack of ^{209}Bi layers, deposed on mylar films (100 um). Fission fragments generated from n- ^{209}Bi interaction generated holes in mylar detected by means of a spark counter

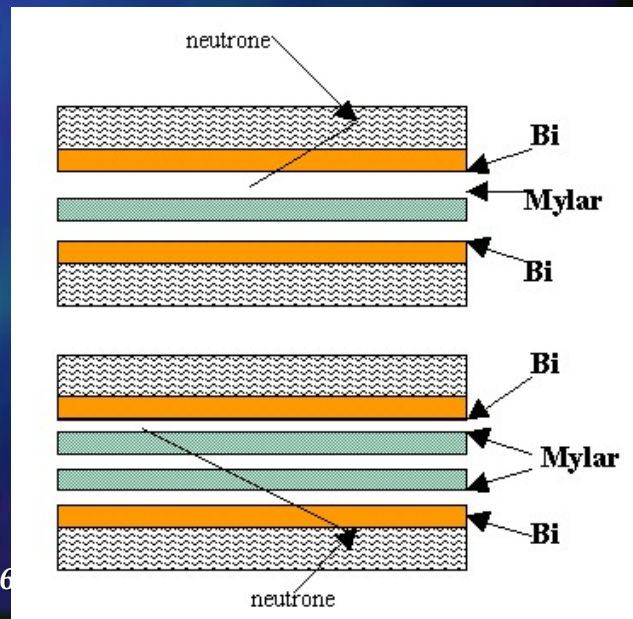
Bubble dosemeter
BD100R 100keV - 20 MeV

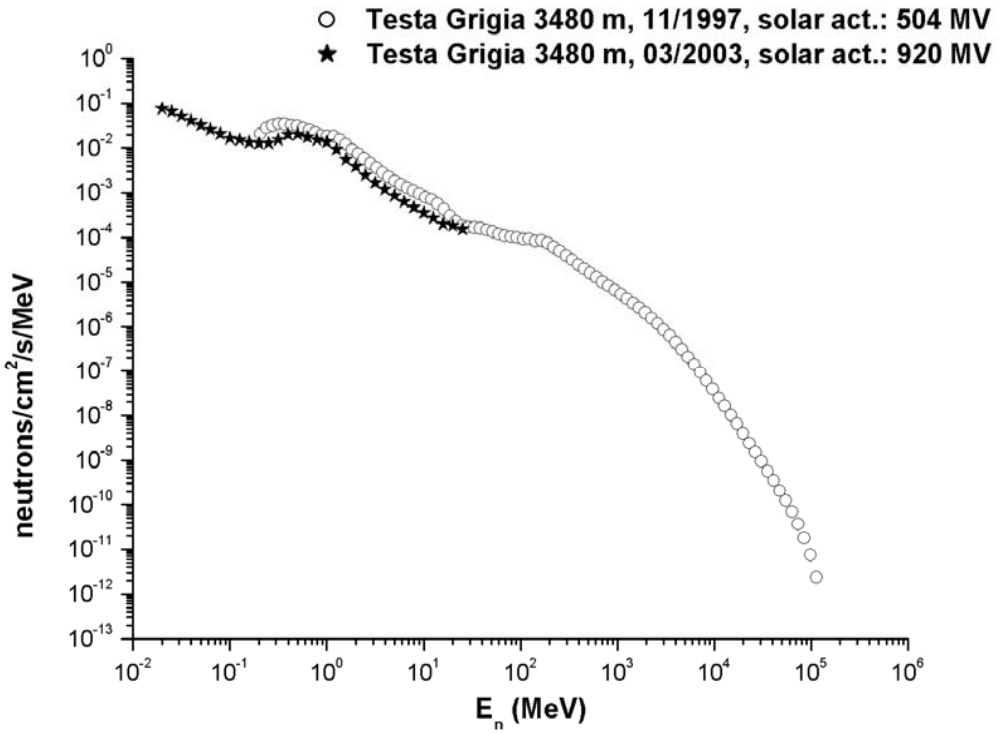
Polycarbonate detectors
1MeV-100MeV

RESPONSE CURVES



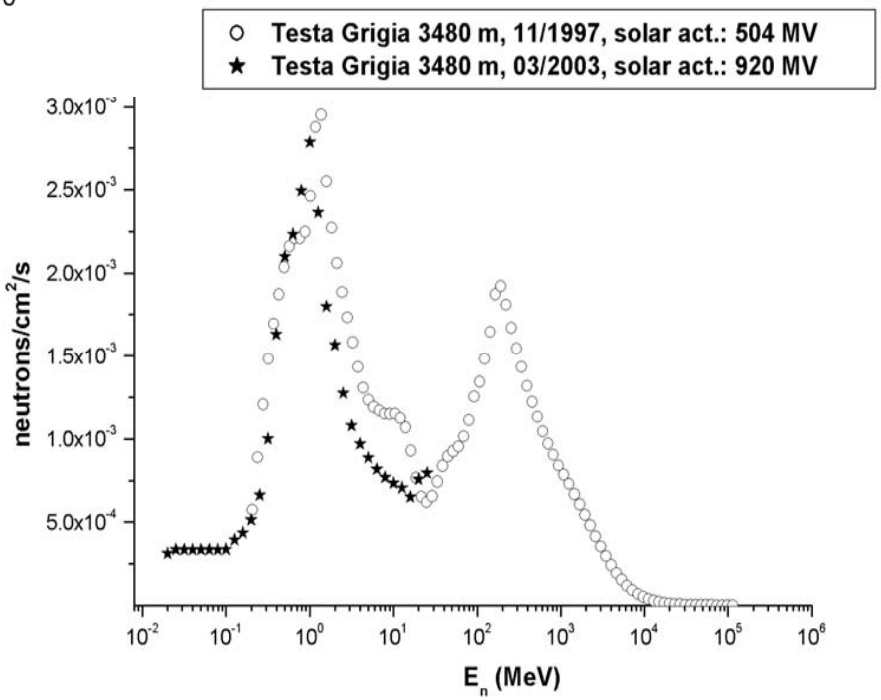
Fission detector ^{209}Bi
100MeV -100GeV





Recent results at Testa Grigia laboratory (March 2003)

Neutron spectra measured with BDS spectrometer compared with a published spectra (1997)



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Monte Carlo Simulations

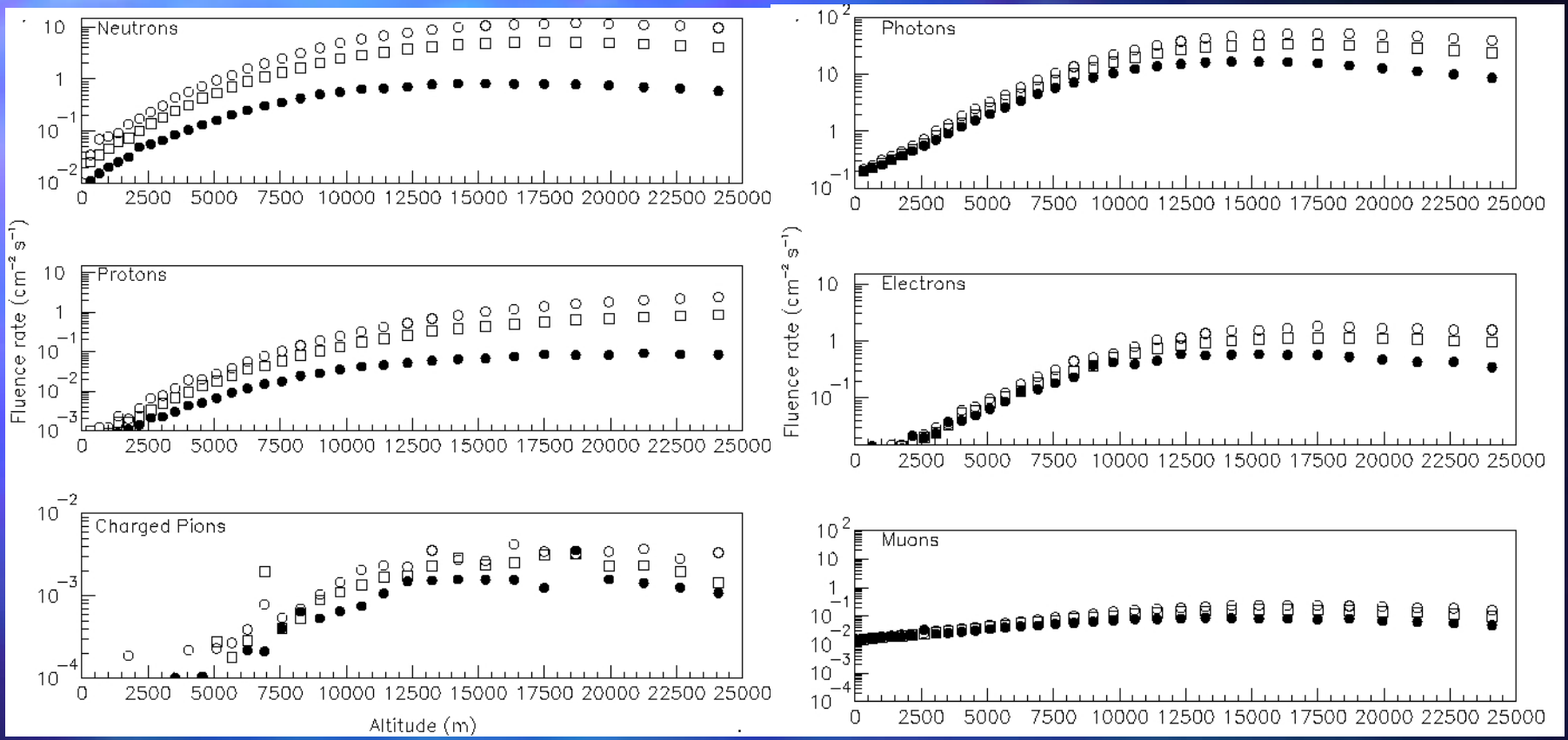
Air shower cascade

- ✓ Spectra of secondary particles calculated using the Monte Carlo transport code FLUKA and GEANT 3.
- ✓ Simulations carried out at solar minimum and solar maximum activity for several geomagnetic cut off.

FLUKA code
is the reference code for high energy nuclear physics

GEANT 3, GEANT 4
have been chosen by ESA as reference code for space environment simulations.

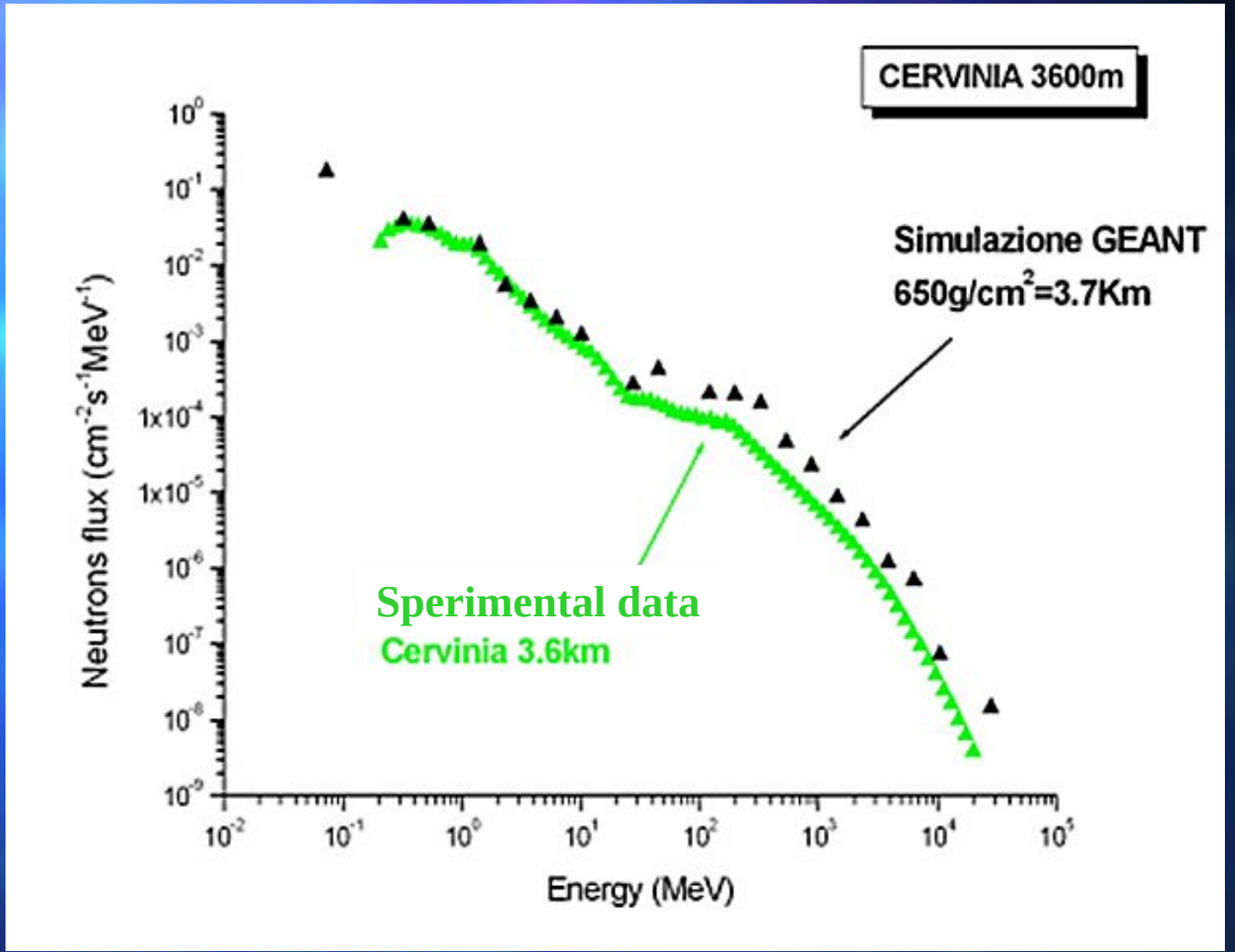
FLUKA simulations



Calculated hadron fluence rates as a function of altitude for different input conditions (○) high latitude, solar minimum activity; (□) high laditude solar maximum activity, (●) low latitude solar minimun activity.

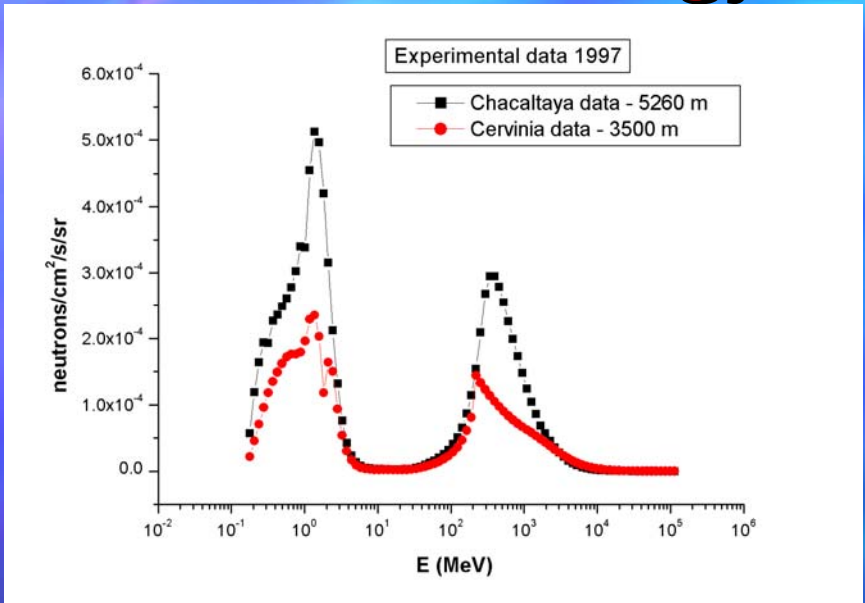
A.Ferrari, M.Pelliccioni, T.Rancati, "Calculation of the Radiation Environment Caused by Galactic Cosmic Rays for Determing Air Crew Exposure", Rad. Prot. Dos. 93, 2, 101-114 Nucl. Tech. Pub. (2001).

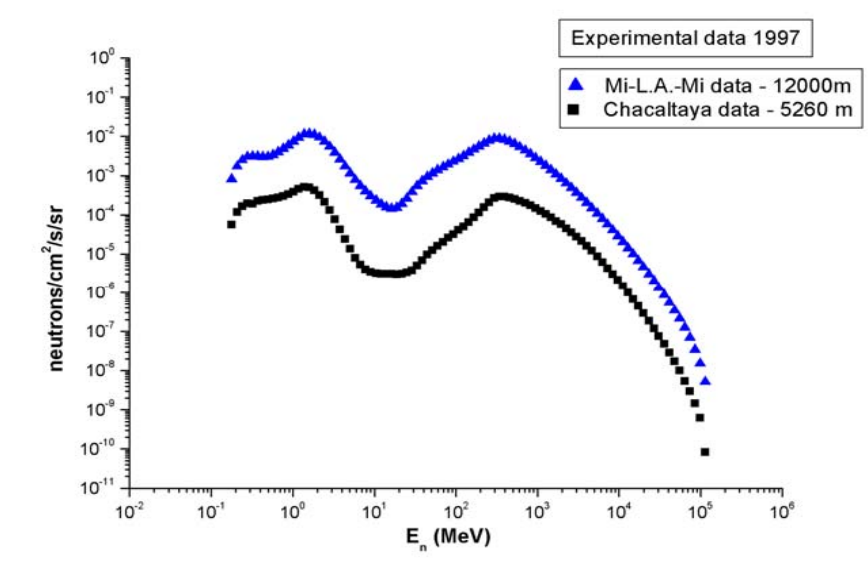
Neutron spectra at Testa Grigia Laboratory



Comparison between sperimental data end simulation

Experimental results using the extended energy range system





EXPERIMENT	GEOGRAPHIC DATA
Testa Grigia lab., Plateau Rosa, Matterhorn, Italy	3480 m, 45°N
Chacaltaya lab., Chacaltaya, La Paz,Bolivia	5260 m, 16°S
Flight Mi-L.A.-Mi	12000 m

altitude m	latitude	integr. flux n/cm²/s	dose rates H*(10) (mSv/h)
3480	45° N	0.09	0.12
5260	16° S	0.12	0.15
12000		2.98	1.8

Gamma scectrometry using NaI detector

Study of installation e calibration of a gamma spectrometer NaI

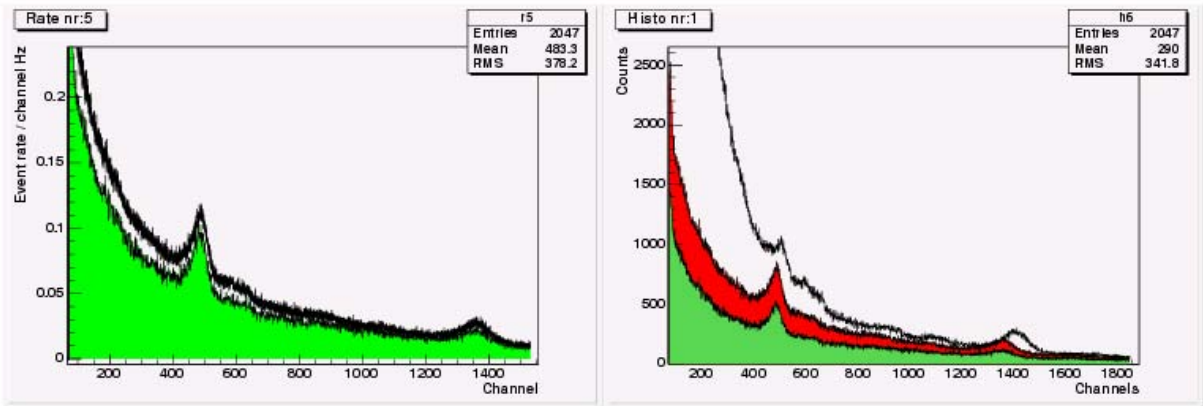


Figure 9: Left: Differential event rate per channel in Hz with 0.5 cm Pb shielding around sides of NaI detector (white) and comparison with result obtained with 1 cm shielding (green). Right: Pulse height spectra of NaI without shielding (white), 0.5 cm Pb (red) and 1.0 cm (dark green).

Gamma rays detectors

16 liquid scintillator
80x 80 x 20 cm^3
With lead and plastic shield

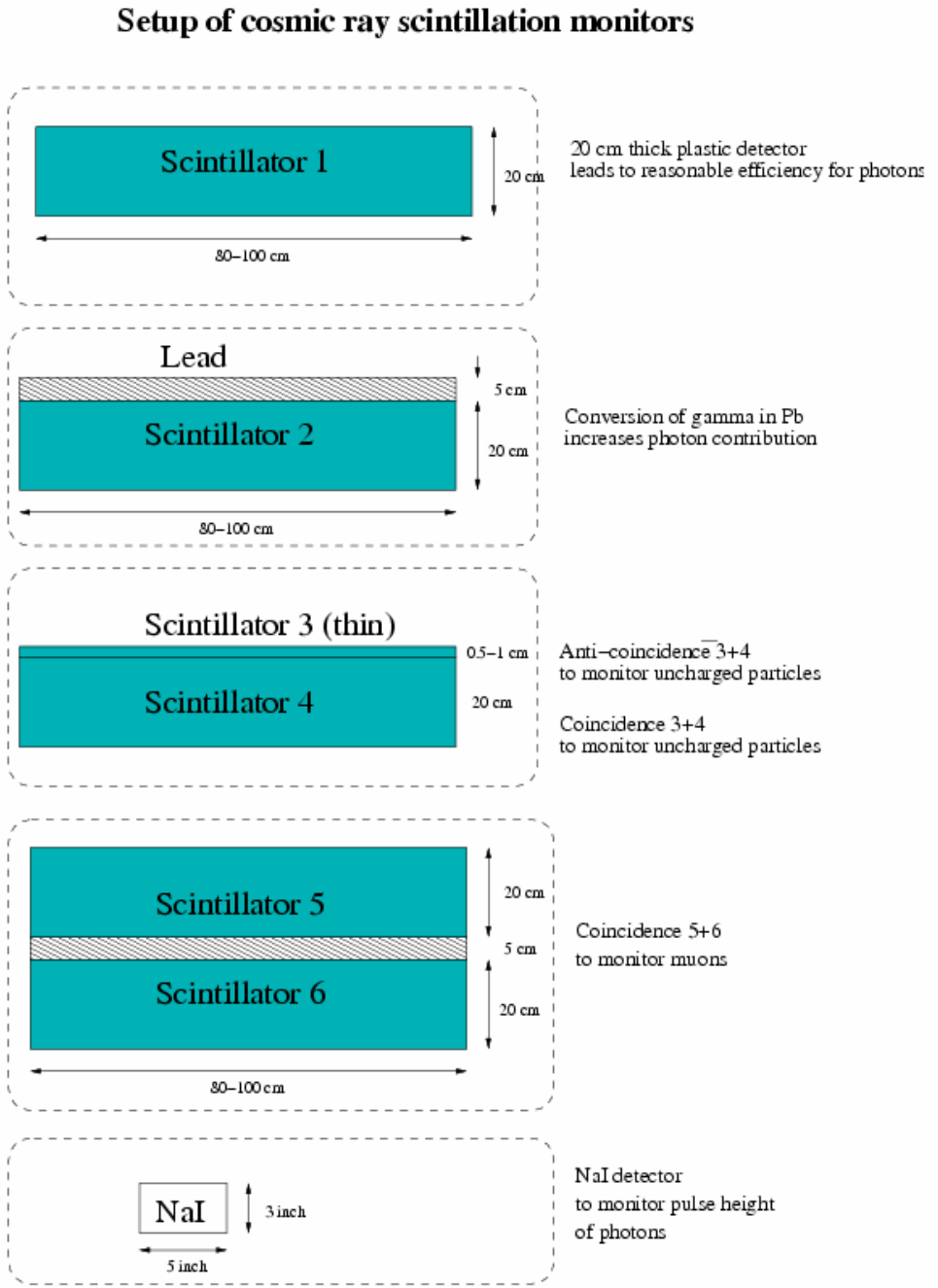


Figure 2: Some possible detector configurations for a cosmic ray monitoring system

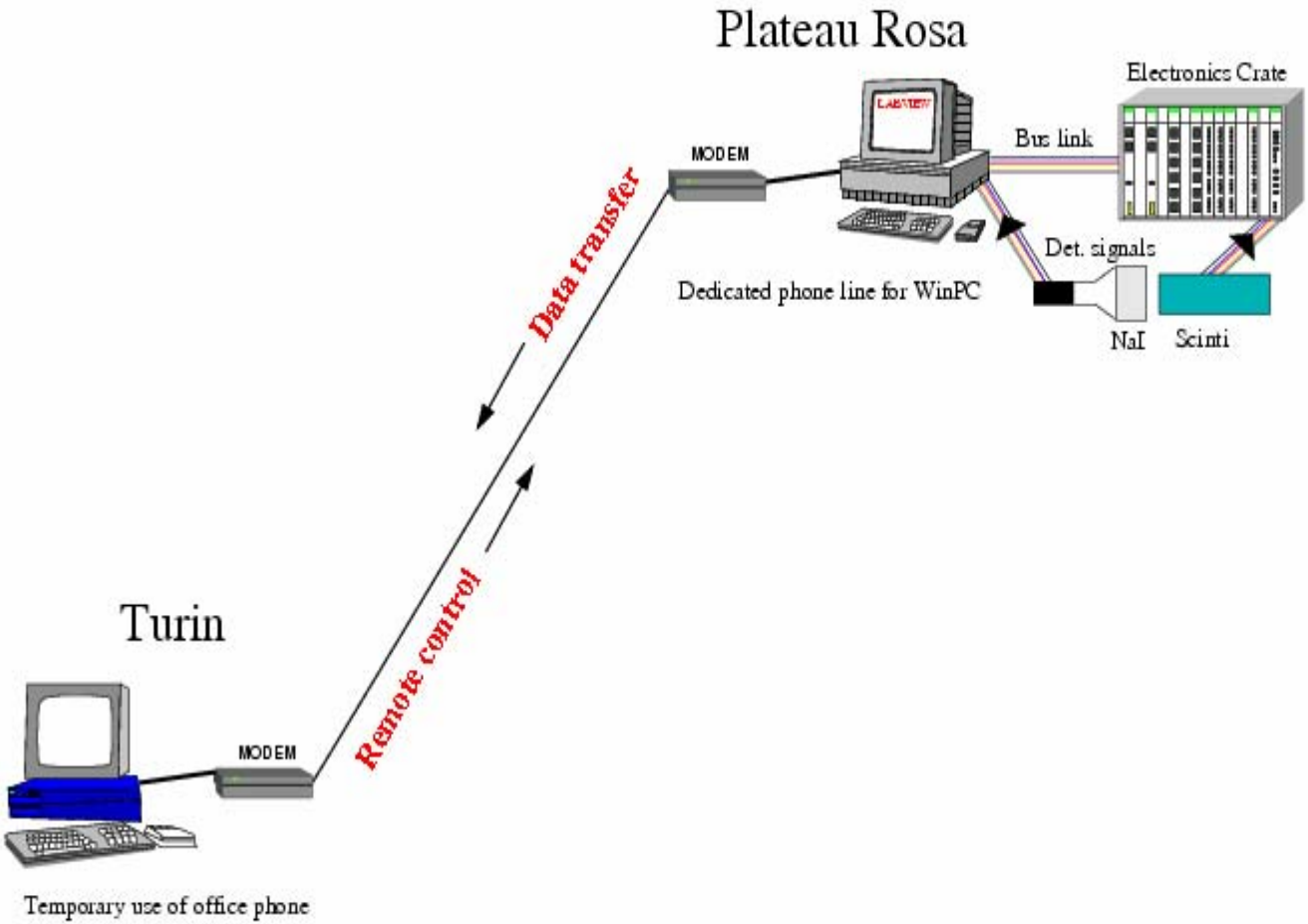


Figure 1: Simple configuration of PC connection between Turin and Plateau Rosa.

Continuous Measurements of Nucleonic Component of Cosmic Rays

- Collaboration with SVIRCO Observatory, Rome

Mobil neutron detector based on Helium counter for calibrated measurements of space weather effects

(in progress)

Study of the effect of UV and radiation on Photosinthetic Organisms

- Collaboration
- UMSA La Paz Bolivia
- IBEV CNR Roma
- Spanish Space Agency
- ESA – ASI

- Photon satellite flight 2006-2007

(BIOPAN Experiment)

STUDY OF RADIATION EFFECTS ON PHOTOSYNTETIC ORGANISMS

✓ TO PRODUCE OXYGEN

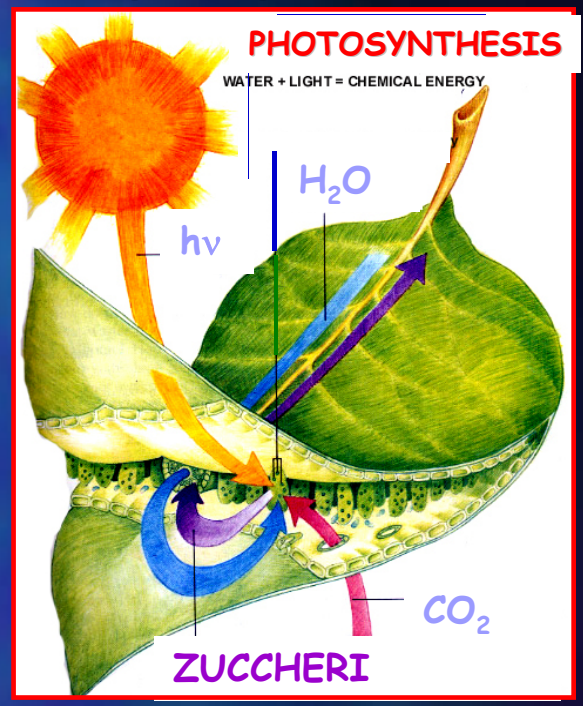
LIGHT ENERGY ⟶ OSSIGENO

$6CO_2+6H_2O+nh\nu \longrightarrow 6O_2 + C_6H_{12}O_6$

RESEARCH OF THE ORGANISMS
MOST RESISTANT TO RADIATION

✓ AS SENSITIVE ELEMENTS
IN A RADIATION BIOSENSOR

RESEARCH OF THE ORGANISMS
MOST SENSITIVE TO RADIATION



The frozen sample has a volume of 150 µl

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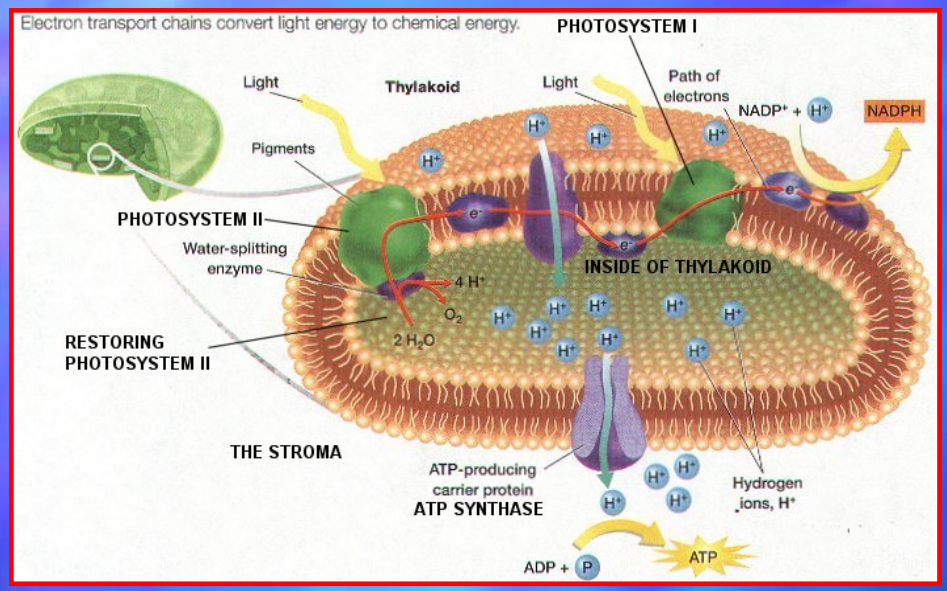
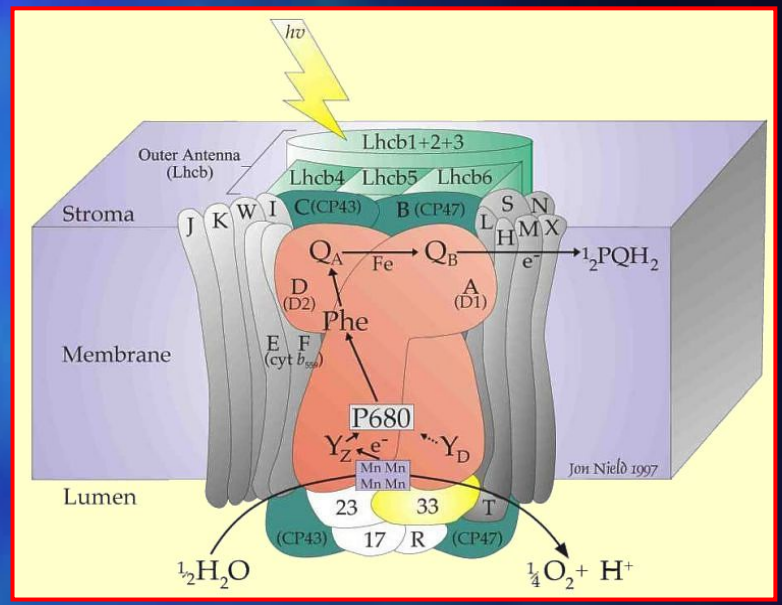
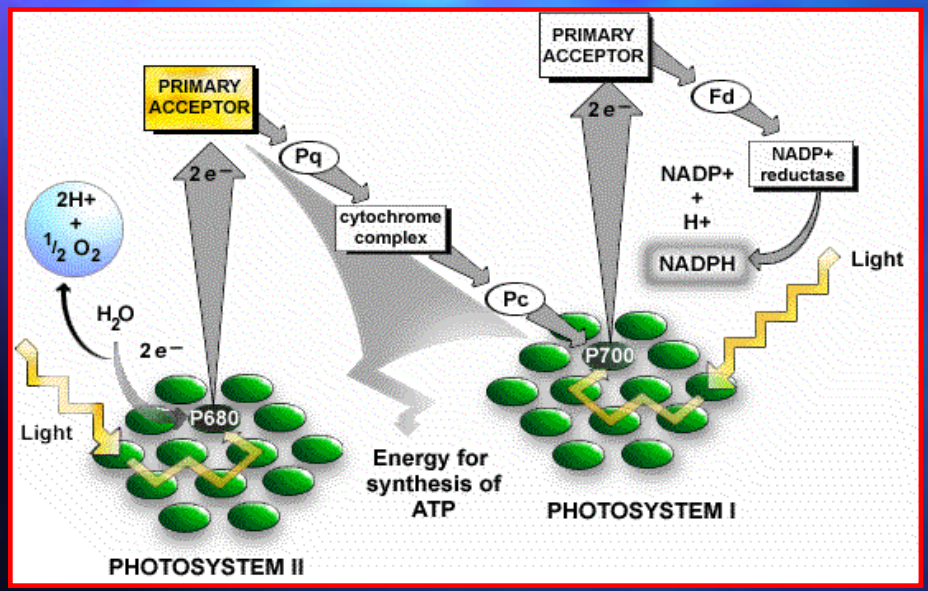
THE SAMPLE: the Photosystem II inside thylacoids







THE CHAIN of REDOX REACTIONS can be affected by radiation

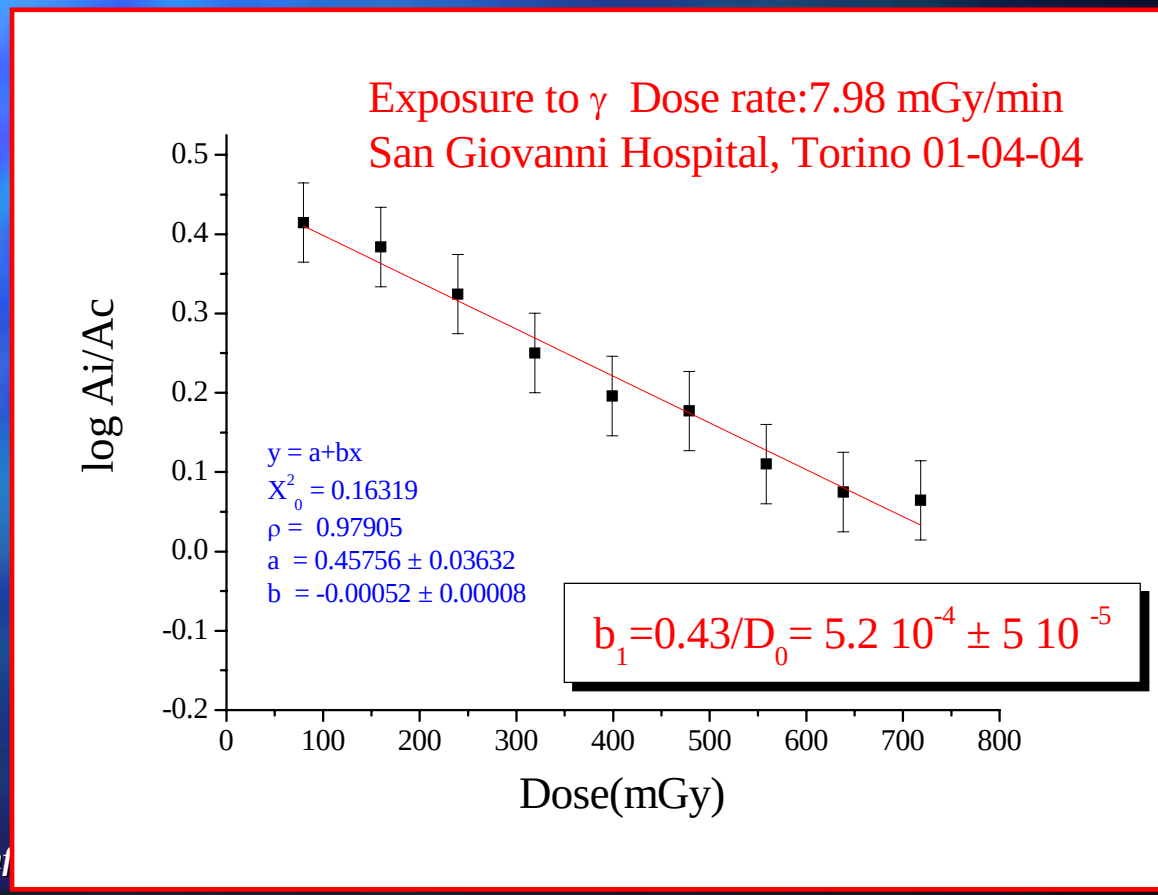
A. Zanini - zanini@to.infn.it - BEOBAL Workshop, Bulgaria, 22-26 October 2005

EXPOSURE TO γ

Exposure to γ

^{60}Co: $E_{\gamma 1}$ = 1173.2 keV

$E_{\gamma 2}$ = 1332.5 keV



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LABORATORI ANGELO MOSSO

Istituto Angelo Mosso

2901meters

Founded in 1907

Study of physiology and medicine in high mountain

CAPANNA REGINA MARGHERITA

Capanna Margherita

4600 meters

Founded in 1894, it was declared in 1903 International Institute

Study of glaciology, meteorology,

Study of the effects of long exposures to low radiation doses

- Collaboration
- Umsa La Paz Bolivia
- PUTRE Research Center, Cile
- Fisiology Department Torino University
- Mountain Medicine Department Pavia University
- Ginecology Hospital S.Anna Torino

To study the effect on the human health of the higher environmental radiation background

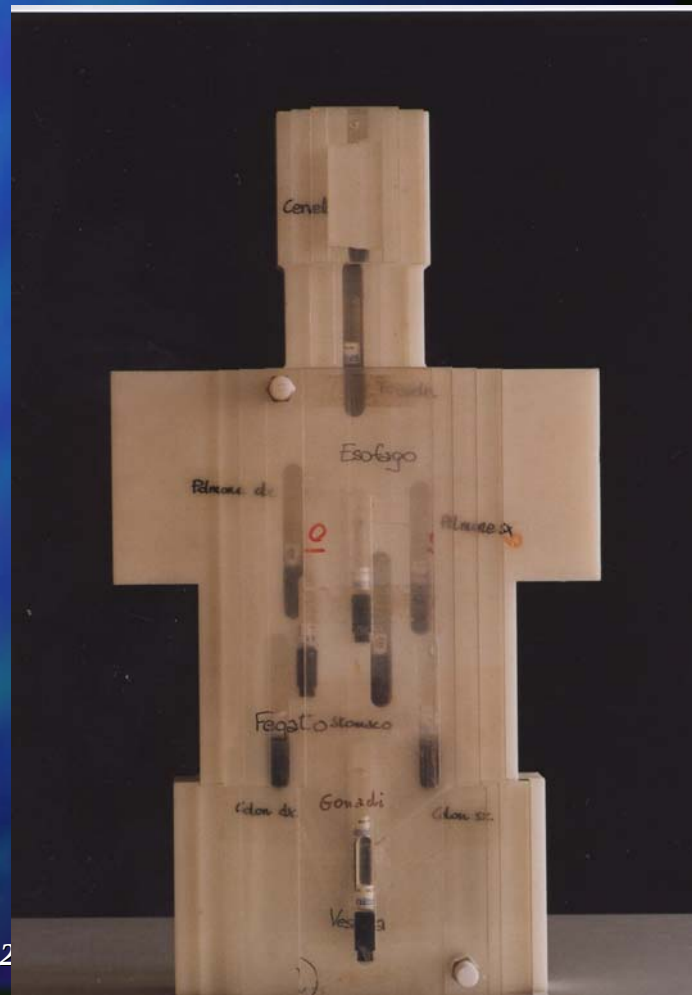
Jimmy Phantom

The anthropomorphic phantom Jimmy has been designed and realized by INFN Sez. Torino, in collaboration with JRC Varese.

It consists of a phantom in polyethylene and plexiglas (tissue equivalent material), with inserted human bone in correspondence of column; composition follows the ICRP indications [1] .

Cavities are placed in correspondence of critical organs and are suitable to allocate passive dosemeters such as bubble detectors, TLDs, makrofolds.

This system allows to evaluate the neutron dose in depth



Jimmy Phantom

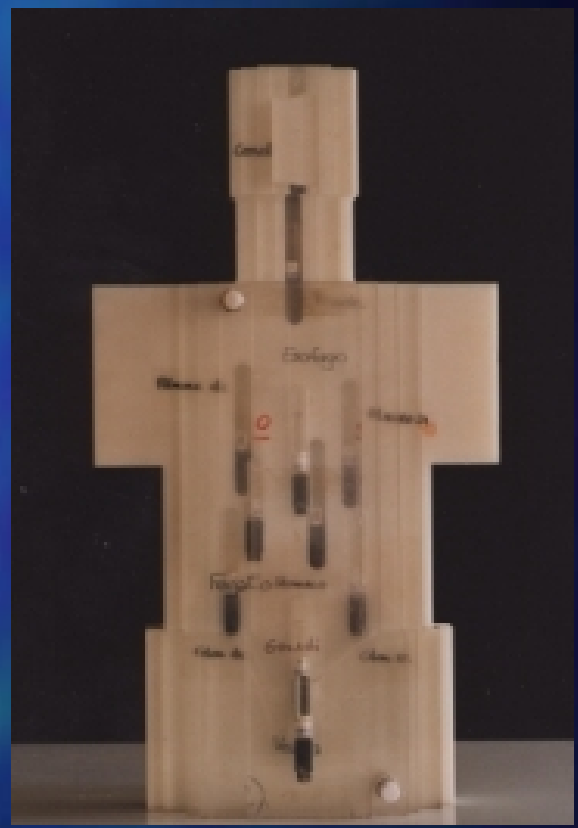
The anthropomorphic phantom Jimmy has been designed and realized by INFN Sez. Torino, in collaboration with JRC (Joint Research Center) Ispra (Va) for neutron dosimetry.

Composition:

8 layers

- 7 plexiglas: ρ=1.190 g/cm^3
  8% H, 60% C, 32% O
- 1 polietilene: ρ=0.920 g/cm^3
  14.4% H, 85.6% C

Dust of human bone in correspondence of column → 0.2% H; 41.4% O; 18.4 %P; 39.9 Ca
ρ =1.930 g/cm^3



Size:

head: 13.5x15x19 cm^3

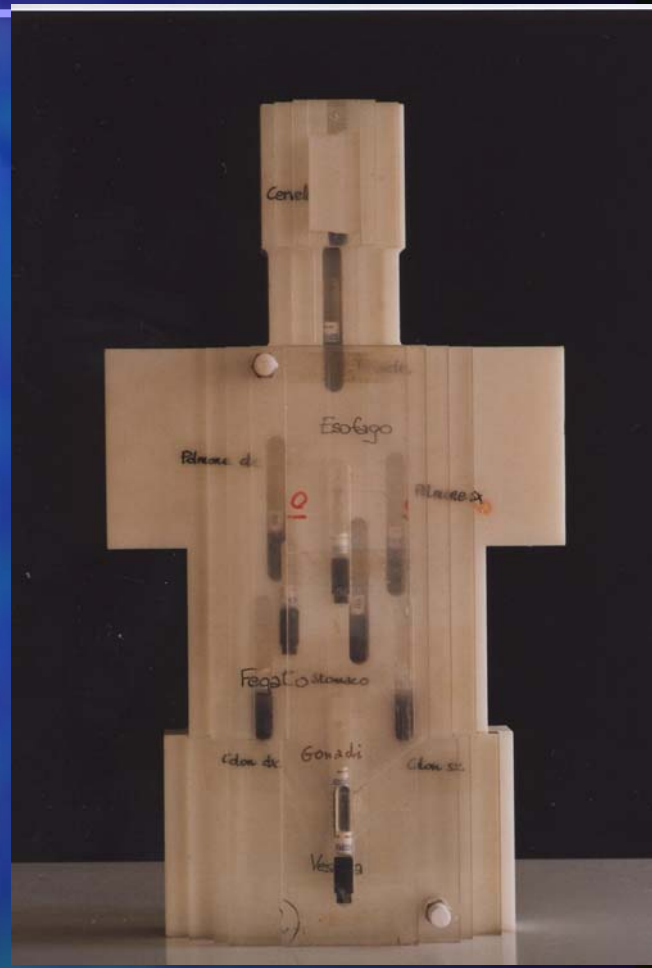
neck: 11x10x13.5 cm^3

trunk: height 59 cm , max width 36 cm, thickness 20 cm

Jimmy Phantom

Main physical characteristics:

- Total weight: 37.1 kg
- 6 plexiglas slabs (21.6 kg)
  8% H, 32% C, 60% O
- 1 big polyethylene slab (14.2 kg)
  14.4% H, 85.6% C
- 1 human bone insert (1.2 kg)
  0.2% H, 41.4% O, 18.5% P, 39.9% Ca
  to simulate the spinal column
- Physical dimensions:
  head: 13.5x15x19 cm^3
  neck: 11x10x13.5 cm^3
  trunk: height 59 cm, max width 36 cm, thickness 20 cm



MEASUREMENTS

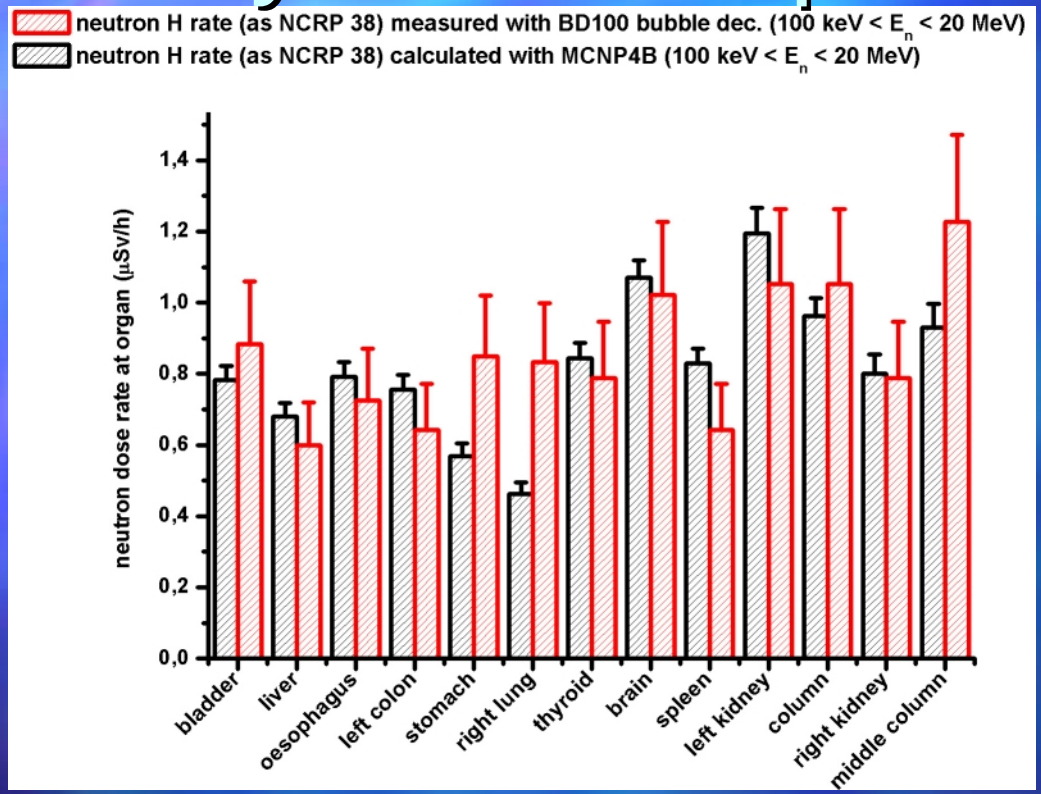
(Projects: INFN - ALITALIA - ASI)

1. **Alitalia flights**
   Roma-Tokyo - h_{mean} = 10649 m
   41° 48′ N 12° 14′ E - 35° 78′ N 140° 32′ E
   Roma - Buenos Aires - h_{mean} = 10433 m
   41° 48′ N 12° 14′ E - 34° 49′ S 58° 32′ W

2. **High mountain laboratory**
   Plateau Rosa, Testa Grigia Laboratory
   h=3480 m,
   45° 56′ N, 7° 42′ E

3. **ASI balloon flights**
   Trapani-Sevilla
   h_{max} = 38000m
   h_{mean} = 29400m

Dose at organs
Tokyo – Rome path



comparison between experimental **BD100R H rates** at organ position and **H_T rates calculated** with simulation code MCNP4B, using the spectrum measured (BDS) inside the phantom

Science Communication

INFN is working on science communication improvment

Communication on HMO activities

1) 15th of January 2006- 28th of February 2006
   Winter Olimpic Games in Torino
   Exibition on European HMO at the Library of Torino University - Historical place (15th century)
2) End 2006- beginning 2007
   Important exibition on HMO at Forte di Bard space- a new space in Valle d'Aosta for Alpine environment activities
3) 2007 Book on HMO " The science Observatories" edited by Electa Mondadori
4) 2007 Hmo Exibition at

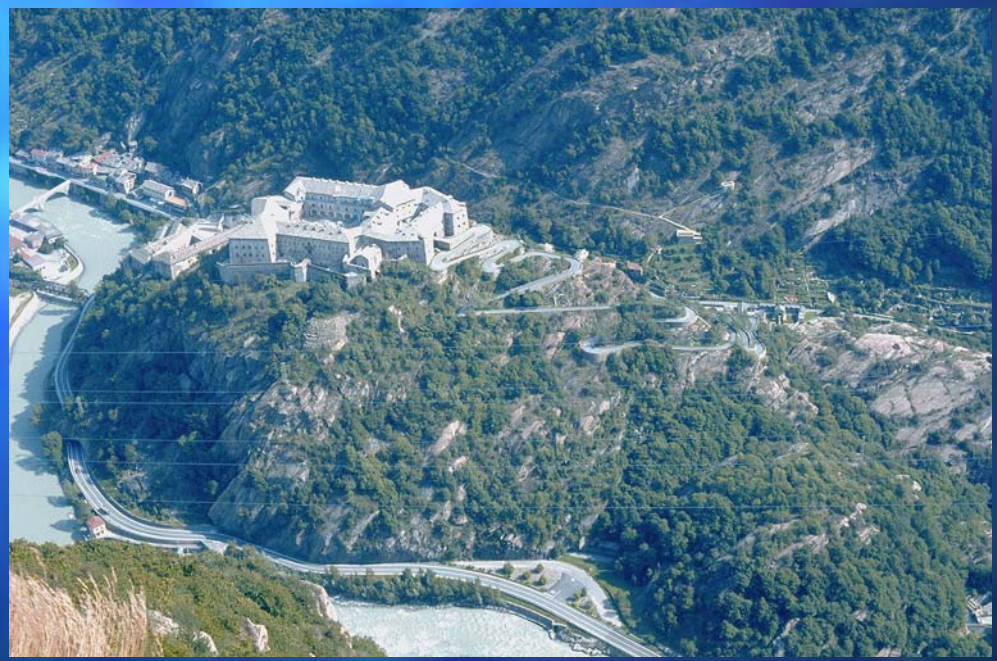
- Observatoire de Paris Paris France
- UMSA La Paz Bolivia
- Berna University Berna Switzerland

Il Forte di Bard Valle d'Aosta, Italy

A new space for Alpine Environment Studies

A. Zanini - zanini@to.infn.it - BEOBAL Workshop, Bulgaria, 22-26 October 2005

Il Forte di Bard Valle d'Aosta, Italy



Il Forte di Bard Valle d'Aosta, Italy

Conferences, Schools, Exibitions, Hotel