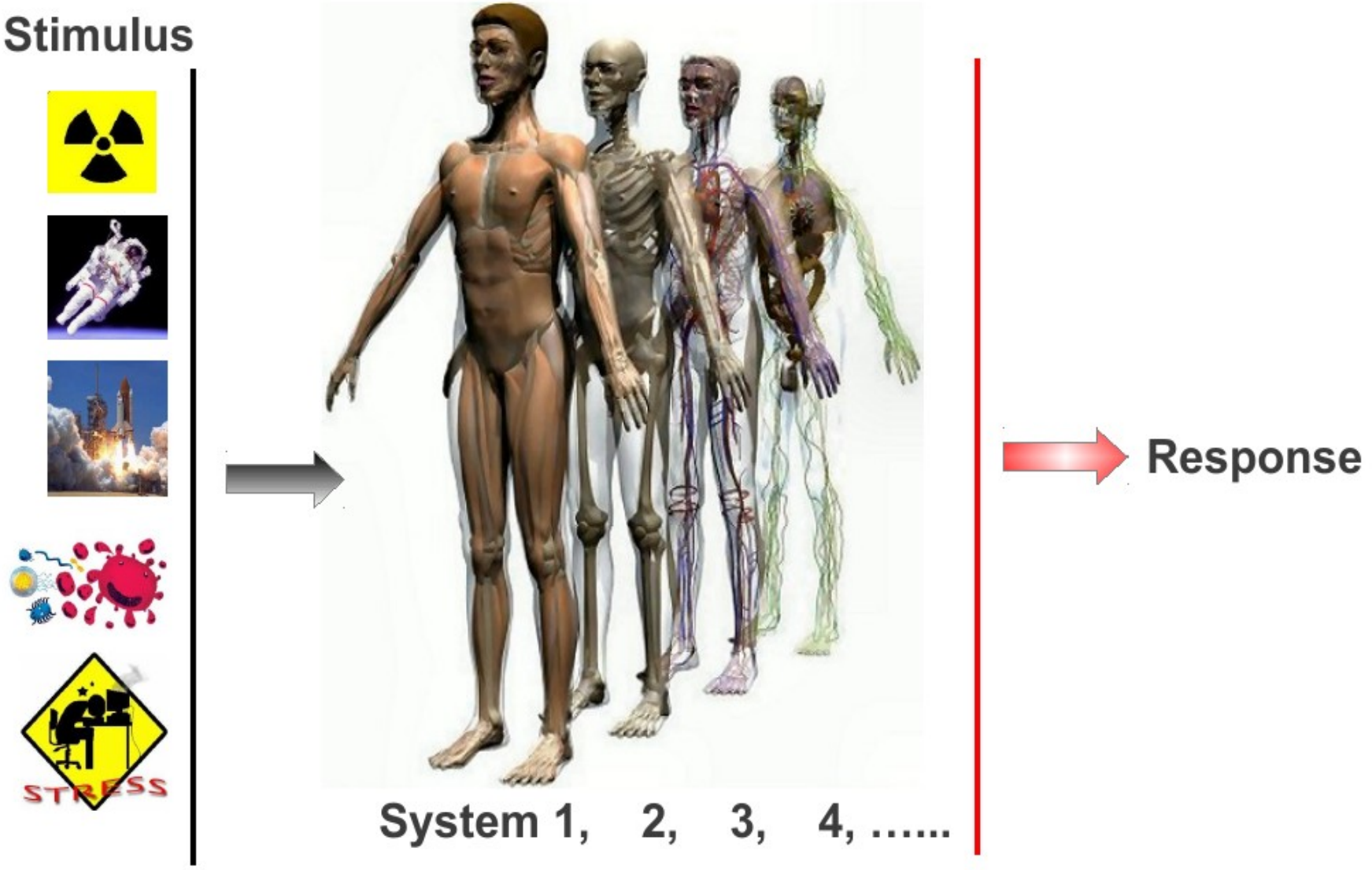
An integrated systemic approach to cosmic radiation biology: from IR spectroscopy to implanted diamond dosimetry.

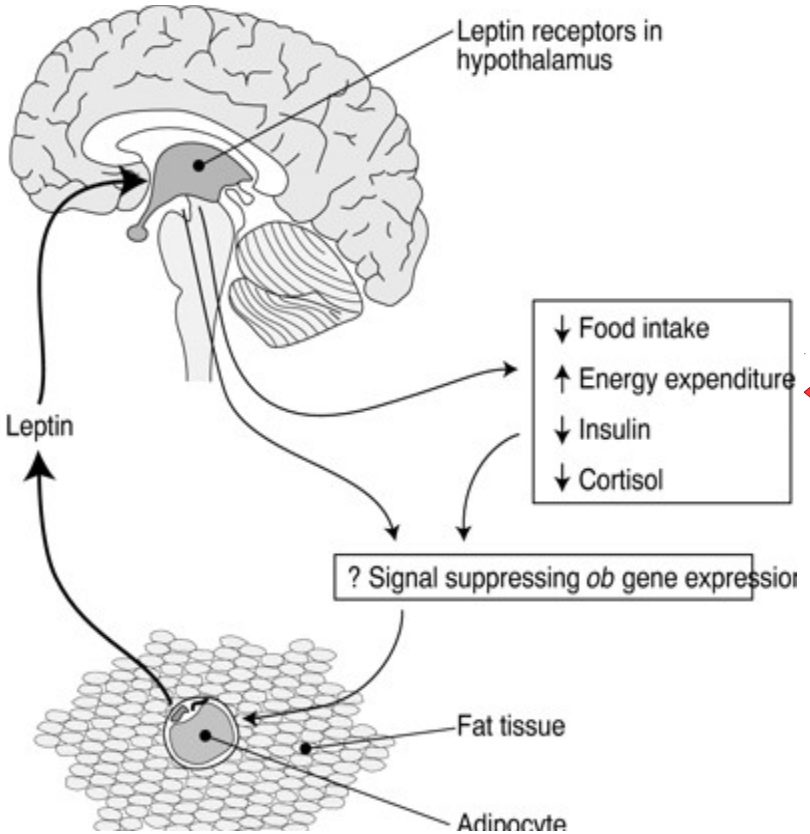
This study aims to apply a systemic approach to unveil the metabolic alteration after radiation effects and space environment stress on cell models, tissues and invertebrates organisms, taking advantage of LNF infrastructures and expertise. FT-IR spectroscopy and imaging can reveal the lipid content variations in radiation exposed tissues, whereas implanted diamond dosimeters detect simultaneously the intensity and position of the delivered radiation. This provides an unique opportunity to understand the mechanisms of radiation effects, simulating space conditions in aircrafts. The effect of natural background shielding in underground laboratory experiments will be also discussed.

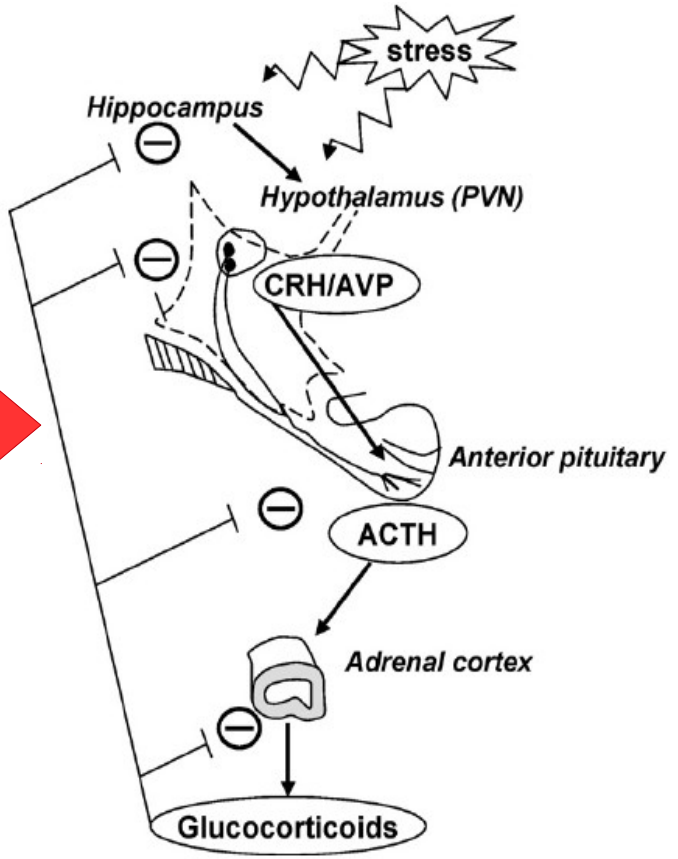
What Next, INFN-LNF, Frascati, 27/02/2015

Holistic, Systemic Approach
(Systems are considered altogether)



Stress-related Metabolisms





Leptin-specific patterns of gene expression in white adipose tissue
Alexander Soukas, Paul Cohen, Nicholas D. Socci, et al.
Genes Dev. 2000 14: 963-980

Corticosteroid–serotonin interactions in the neurobiological Mechanisms of stress-related disorders

Neuroscience and Biobehavioral Reviews 32 (2008) 1174–1184

Mechanism of Leptin network

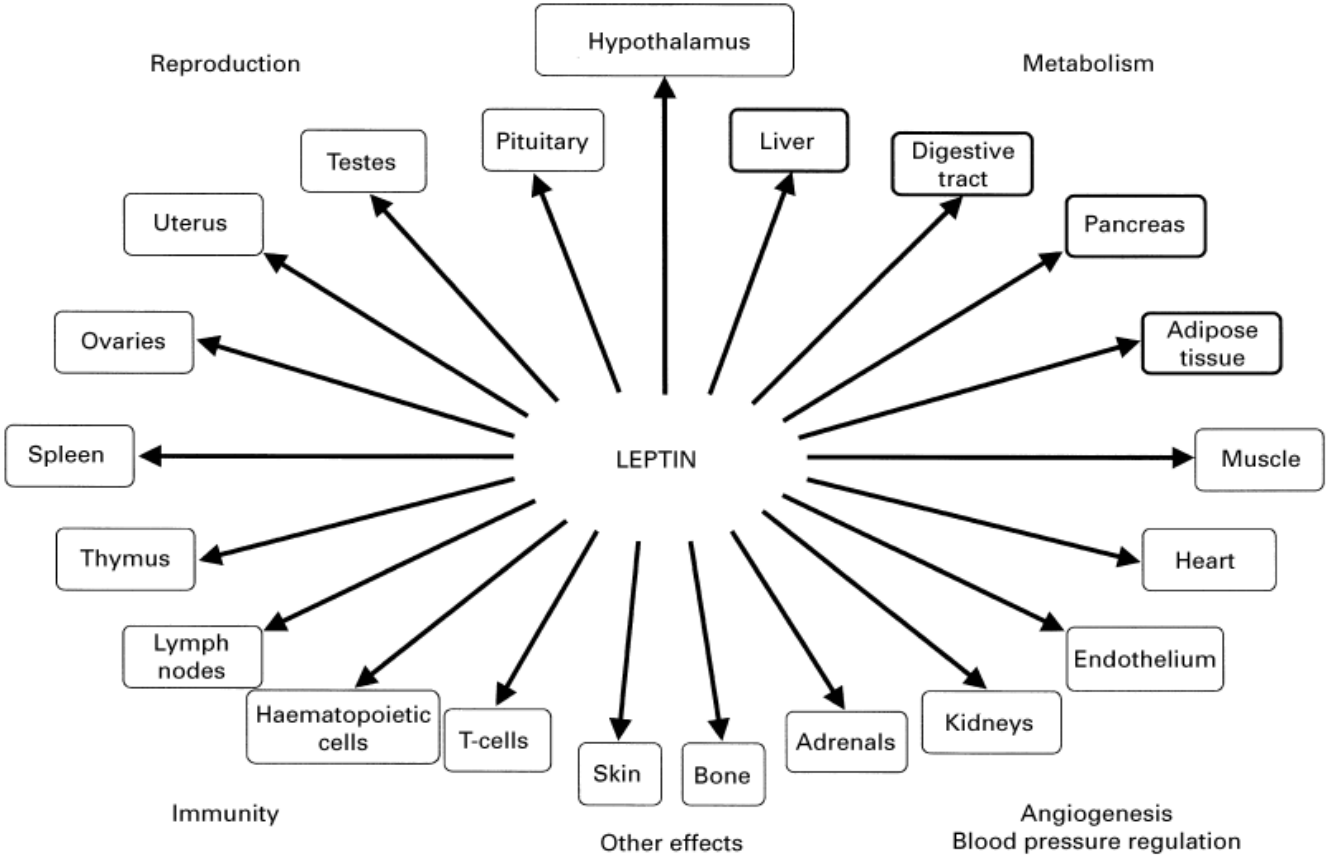


Fig. 1. Localization of functional leptin receptors showing the involvement of leptin in peripheral effects.

Proceedings of the Nutrition Society (2001), **60**, 301–318

Corticosteroid–serotonin interactions in the neurobiological mechanisms of stress-related disorders

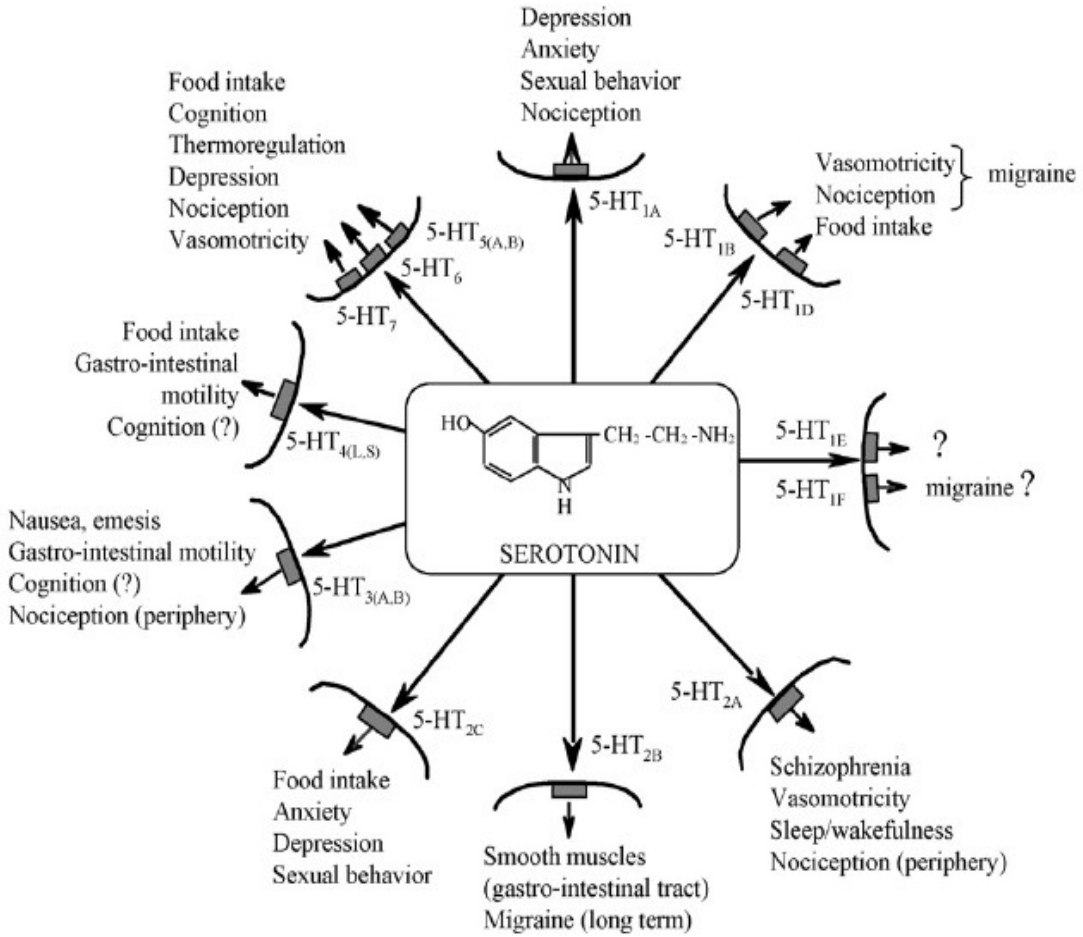
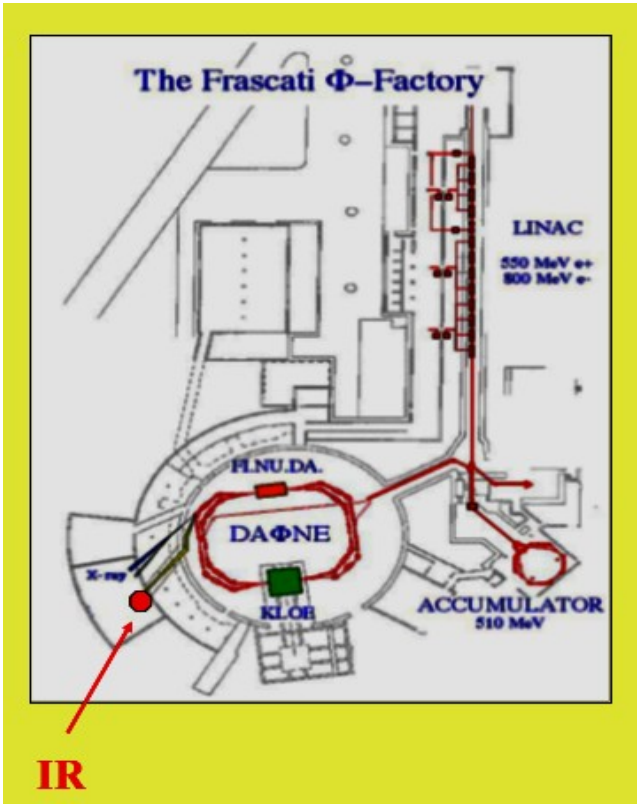


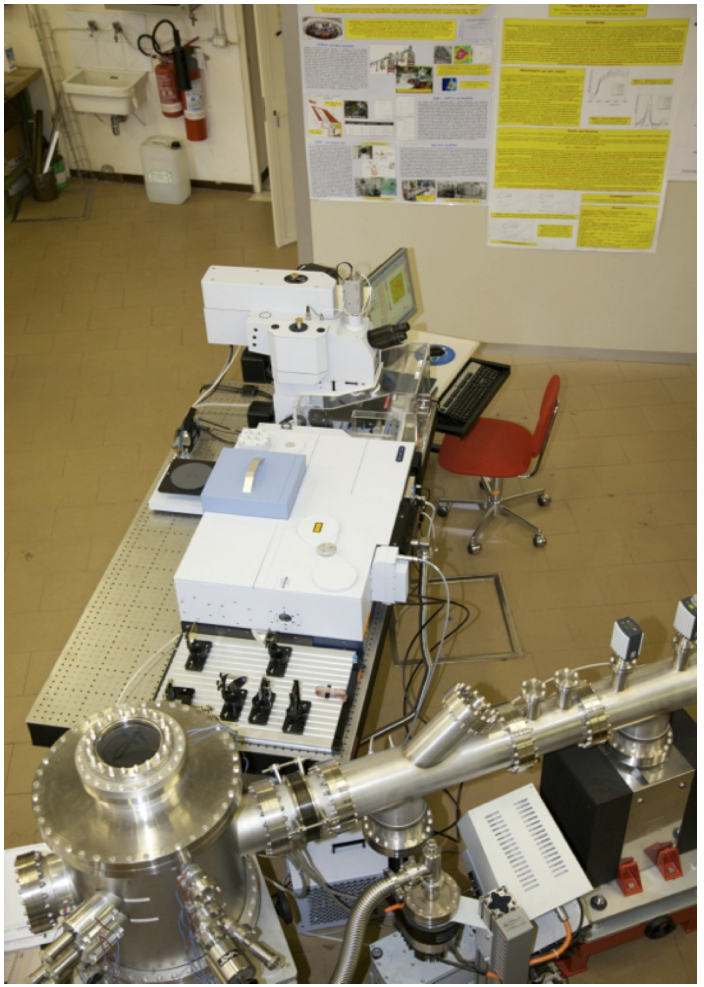
Fig. 3. Multiple 5-HT receptor-mediated functions. Schematic overview of the 5-HT receptor types and their involvement in physiological, psychoaffective and physiopathological conditions.

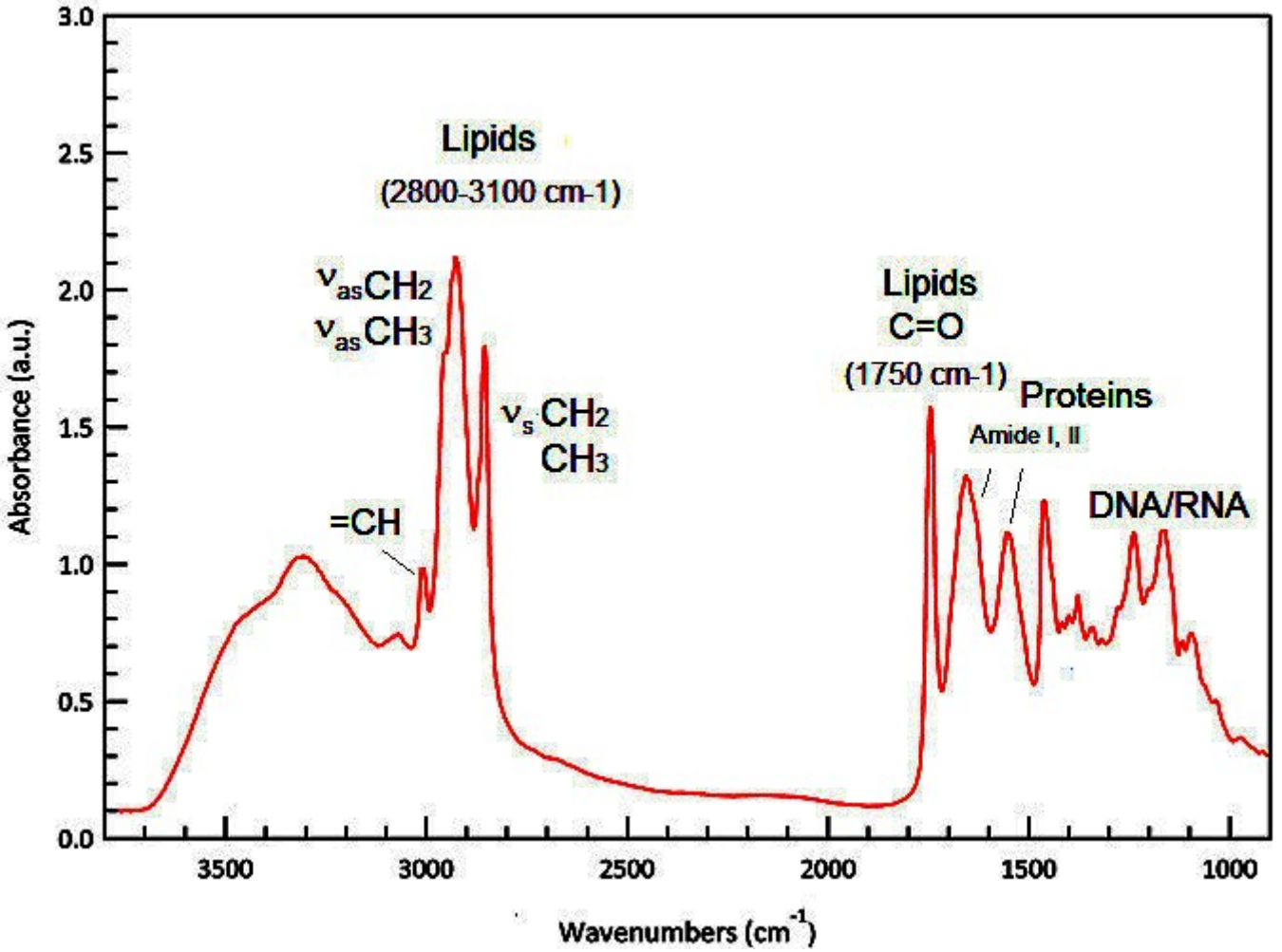
Corticosteroid–serotonin interactions in the neurobiological Mechanisms of stress-related disorders

Neuroscience and Biobehavioral Reviews 32 (2008) 1174–1184

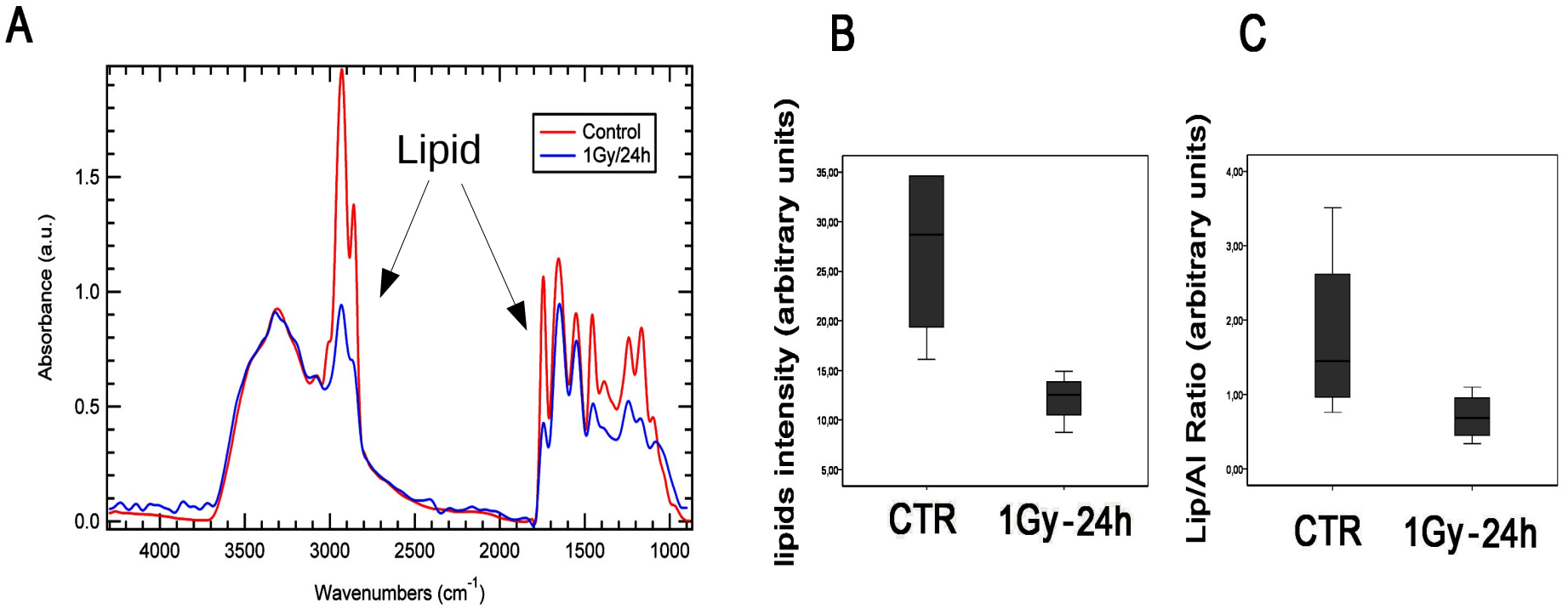
Equinox 55 (Bruker), Sinbdad interferometer in the LNF Φ-Factory





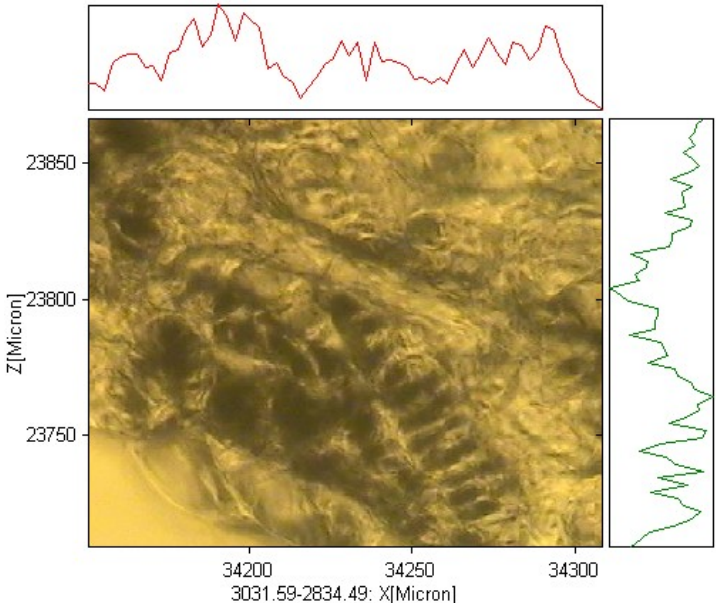

Lipids
(2800-3100 cm-1)
$\nu_{as}CH_2$
$\nu_{as}CH_3$
ν_s CH_2
CH_3
=CH
Lipids
C=O
(1750 cm-1)
Proteins
Amide I, II
DNA/RNA
Absorbance (a.u.)
Wavenumbers (cm^{-1})
3.0
2.5
2.0
1.5
1.0
0.5
0.0
3500
3000
2500
2000
1500
1000

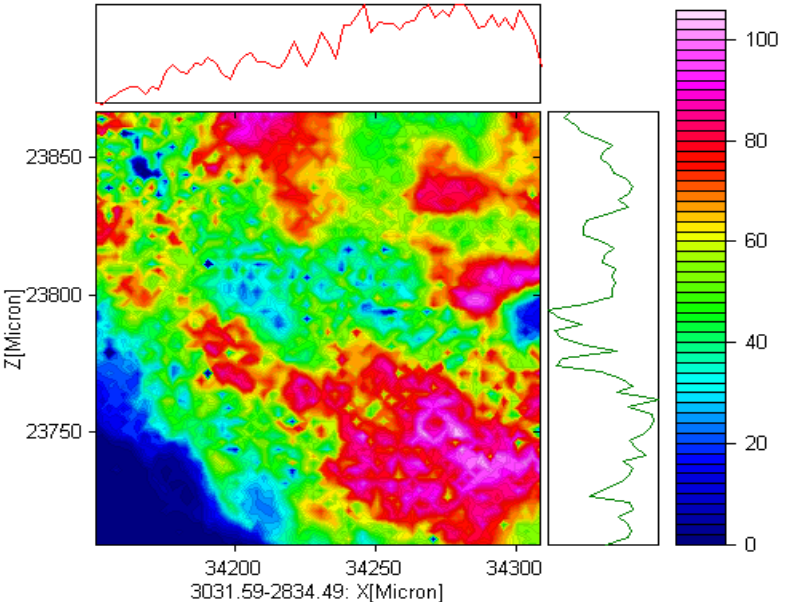
FT-IR spectroscopy of C57Bl/6 skin: Ctrl *vs* irradiated



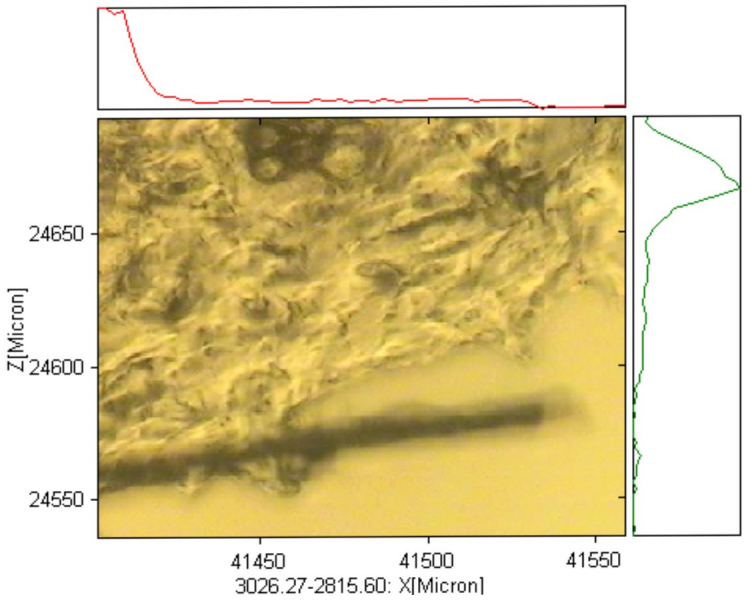
FT-IR spectroscopy of C57Bl/6 skin: Ctrl *vs* irradiated

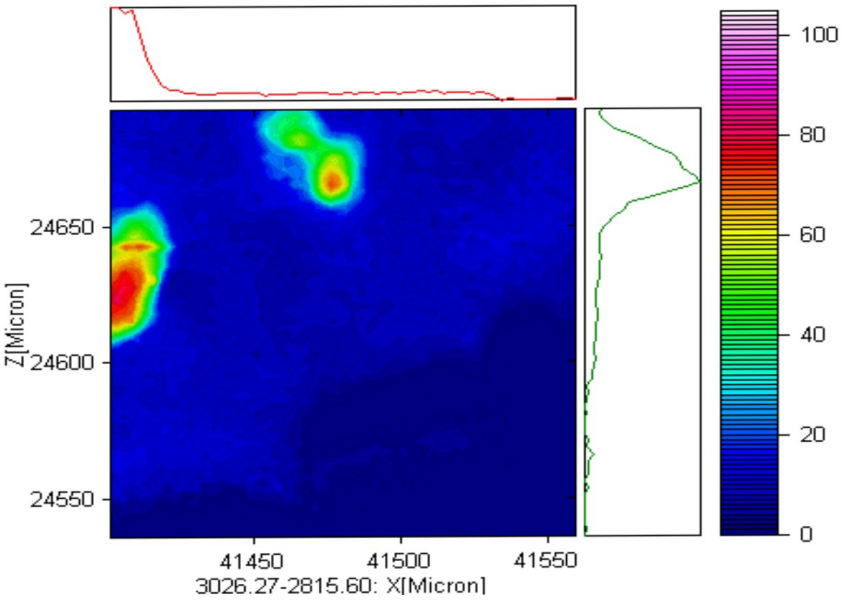
Ctrl





Irr.

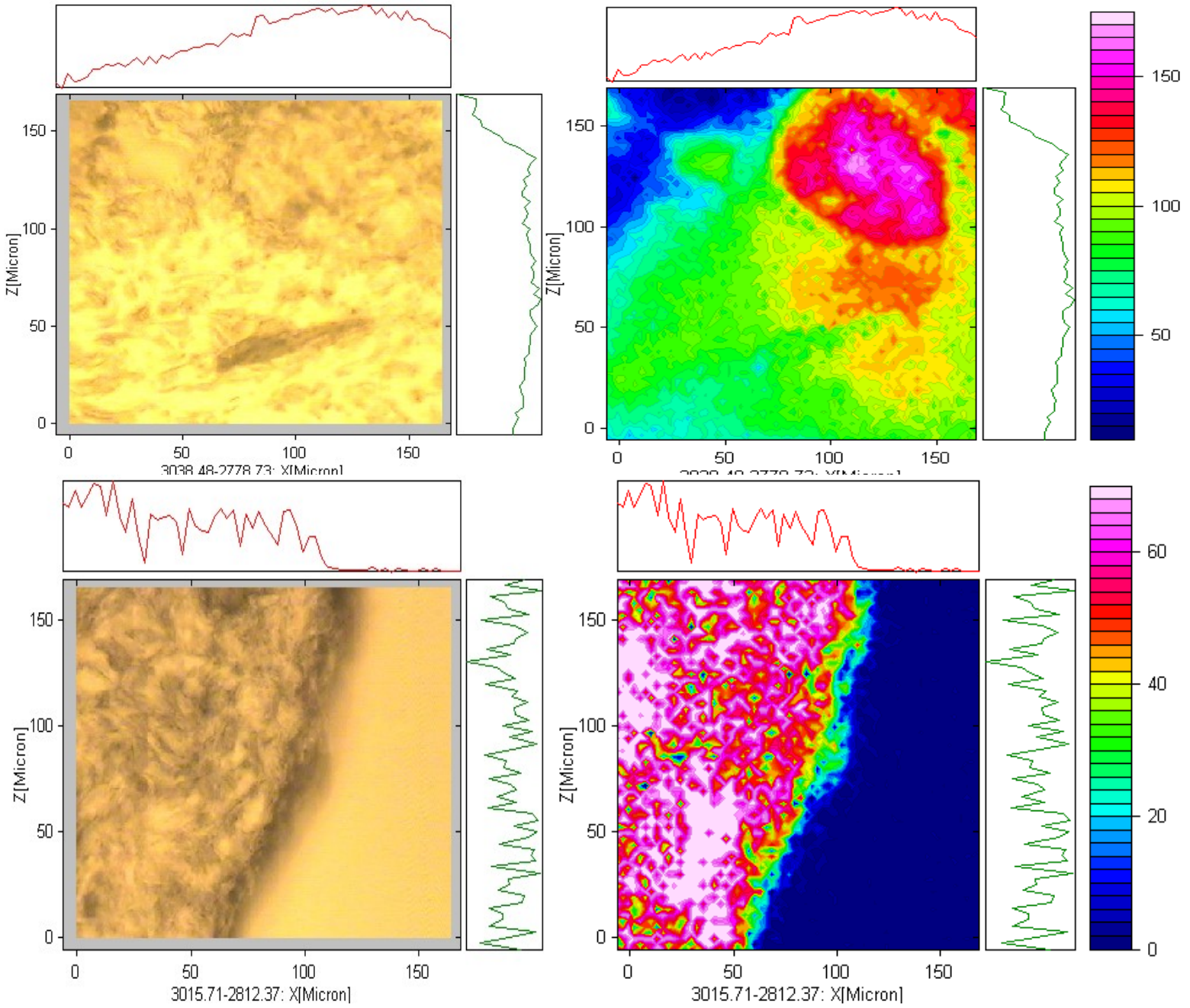




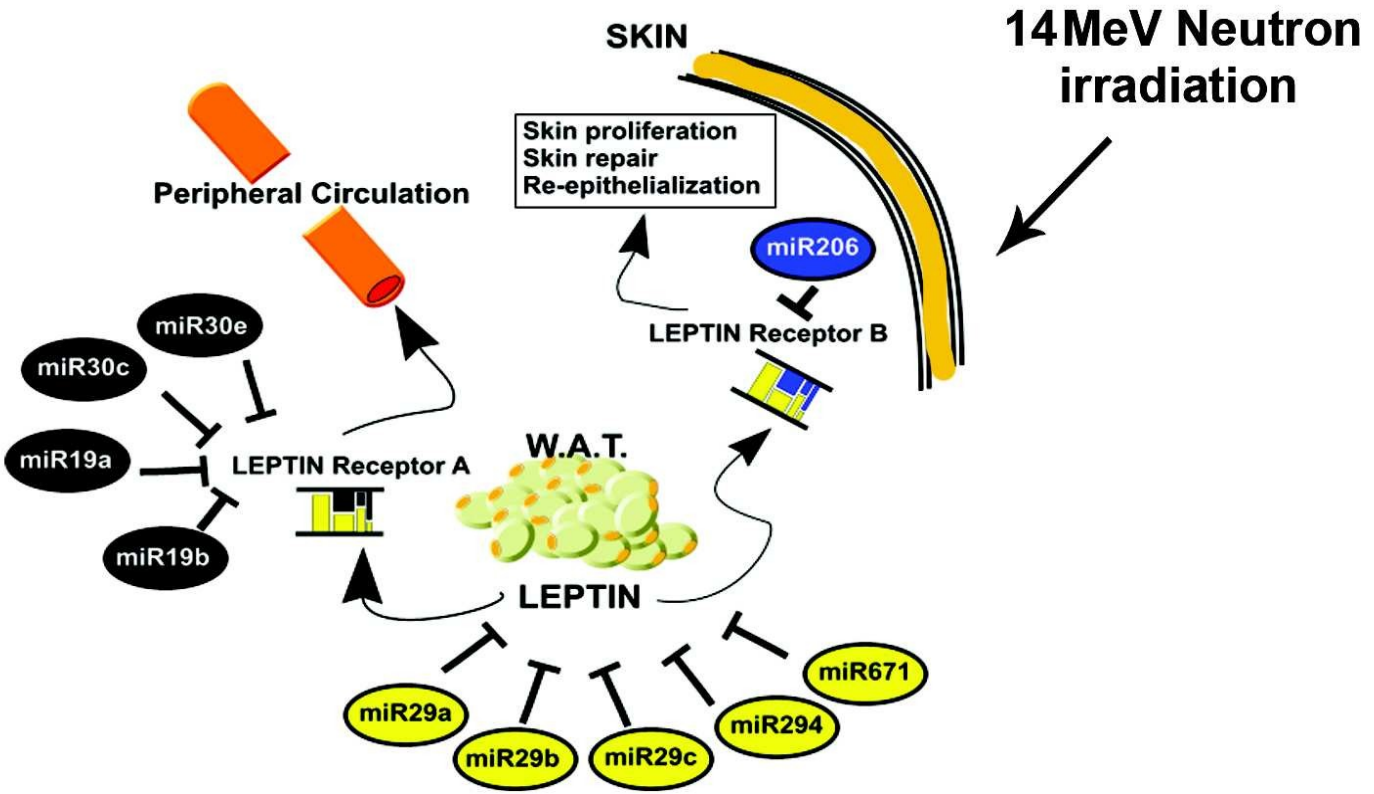
FT-IR spectroscopy of CBA/J skin: Ctrl *vs* irradiated

Ctrl

Irr.



Conclusion and perspectives on Lep and lipids metabolism

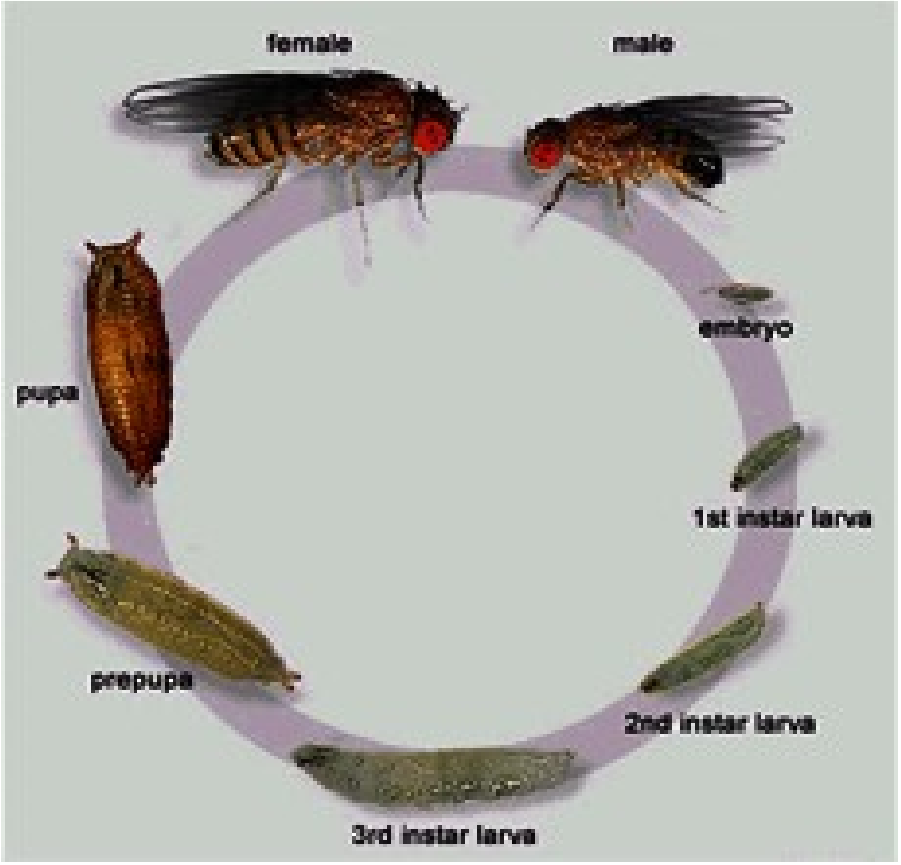


Natural Radiation Background shielding: LNGS+LNF

Why Drosophila melanogaster?

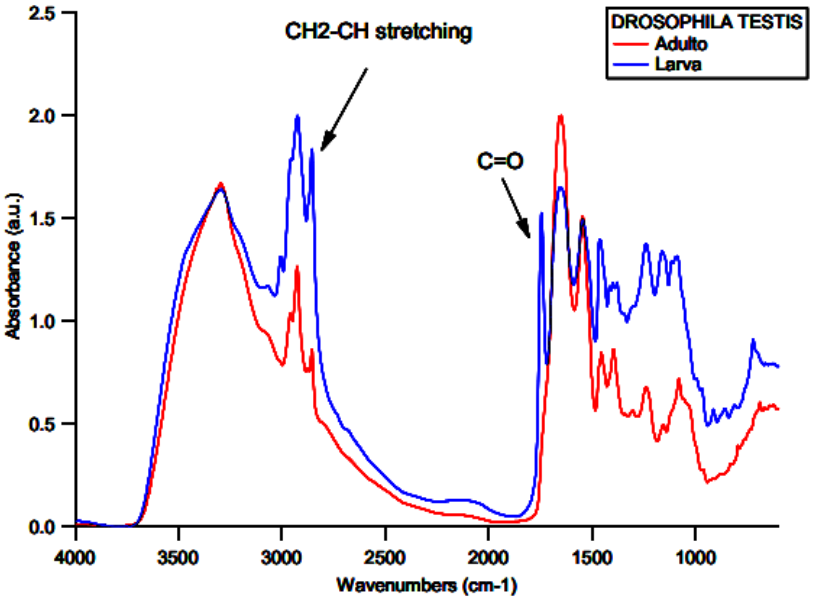
The fruit fly Drosophila melanogaster is a model organism extensively used since early 20th century to study the principles of genetics and development.
It is small and has a simple diet. Due to its very short life cycle (about two weeks at 25 C) large-scale crosses can be set up and followed through several generations in a matter of months. In addition, cytological analysis of chromosomes can easily allow detection of chromosome breaks and rearrangements.
Extensive genetic knowledge about Drosophila melanogaster , collected for over a century, combined with the highly sophisticated techniques in molecular biology and targeted mutagenesis are available.
Due to these advantages, Drosophila melanogaster is still widely used in modern genomic and proteomic studies.
Basic pathways of development, such as patterning of the primary body axes, organogenesis, wiring of a complex nervous system and control of cell proliferation were found to be highly conserved between flies and humans.

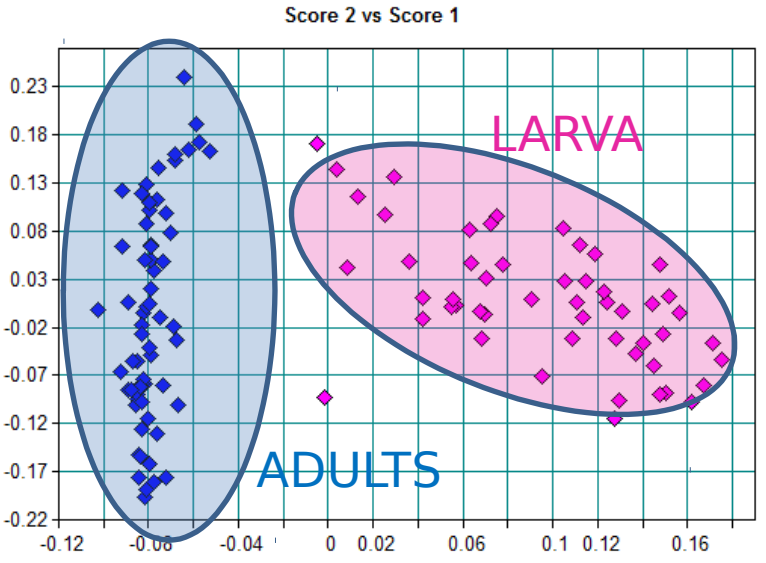
Natural Radiation Background shielding: LNGS+LNF



Specific Aim: Breed drosophila in the external and underground facilities. To monitor the adaptive potential of DNA repair mechanisms in *Drosophila melanogaster* we will perform both genetic and cytological tests. The adaptive potential comprises capability to reproduce and developmental attitude.

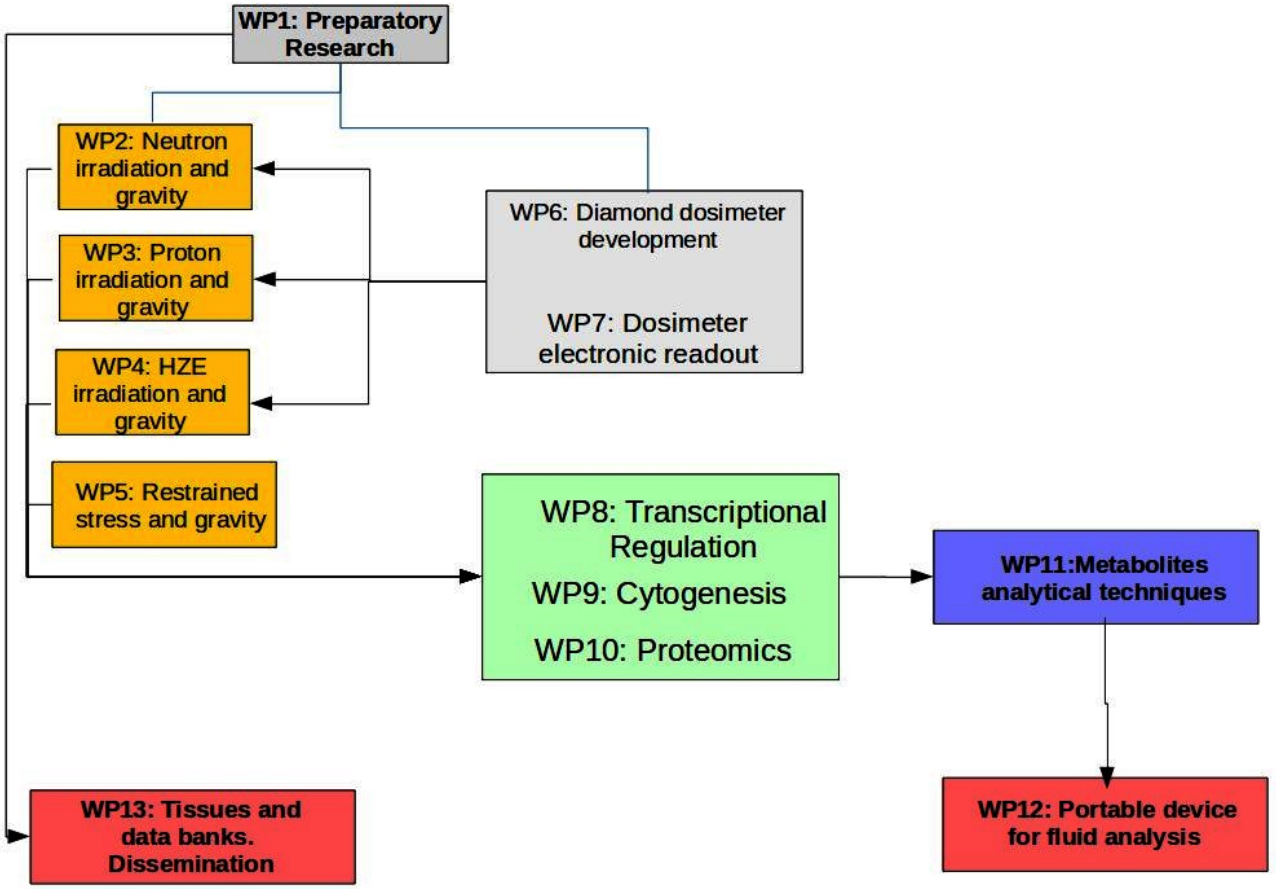
Preliminary experiments on Drosophila Melanogaster By FT-IR Spectroscopy (LNF)





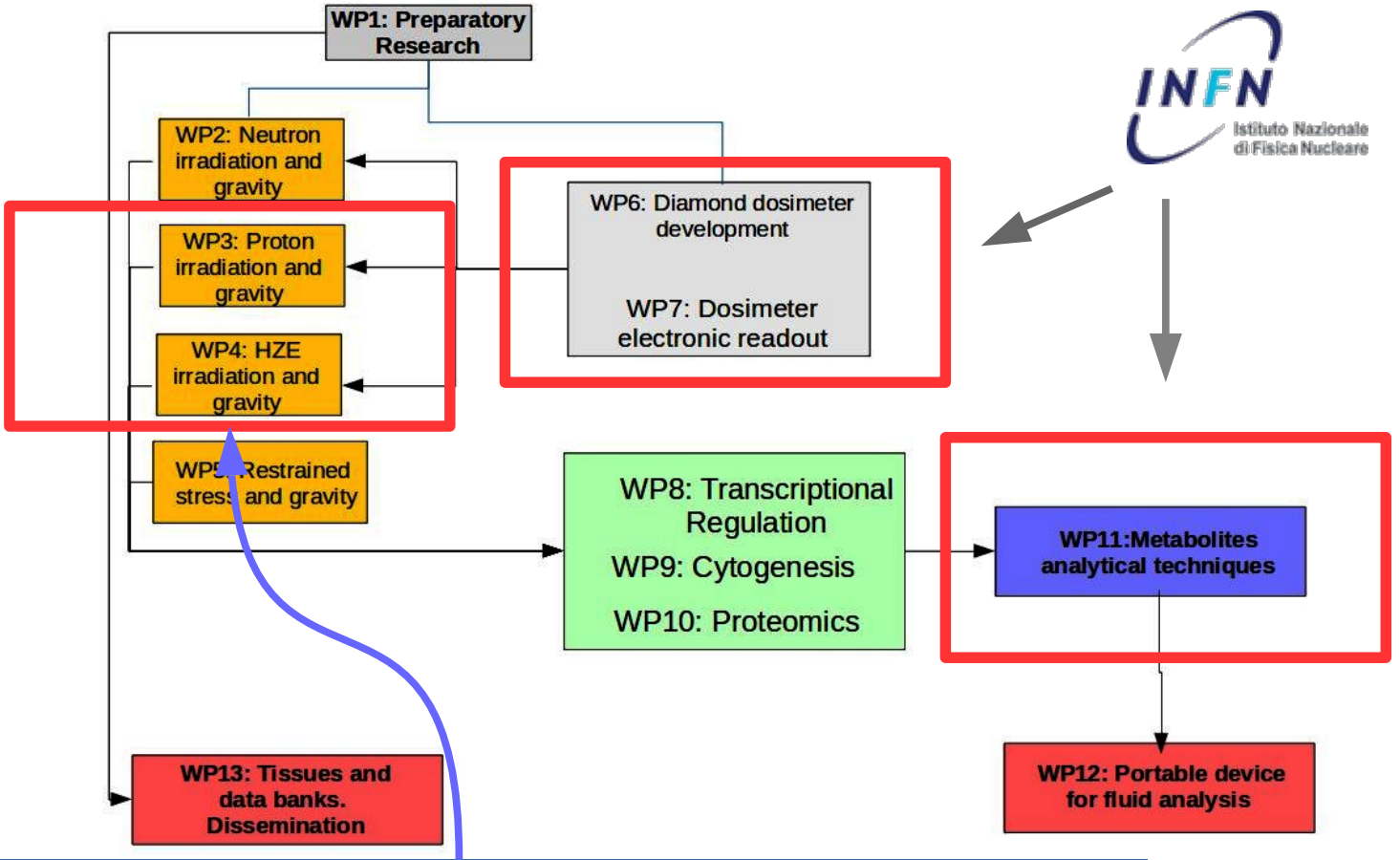
Principal Component Analysis
Preprocessing: 1 derivative + vector normalization
N. Spectra=114

Perspectives: MONSTRE Consortium, call “SPACE”, EU



Perspectives: MONSTRE Consortium, call “SPACE”, EU

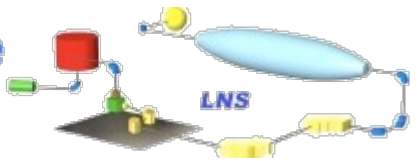
Laboratori Nazionali di Frascati



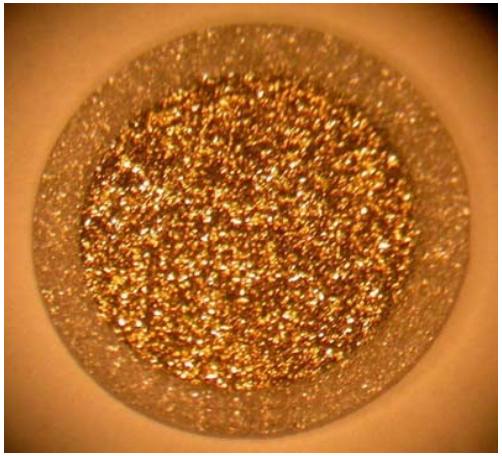
INFN Istituto Nazionale di Fisica Nucleare

Istituto Nazionale di Fisica Nucleare

Laboratori Nazionali del Sud



Perspectives: MONSTRE Consortium, call “SPACE”, EU (Three years)



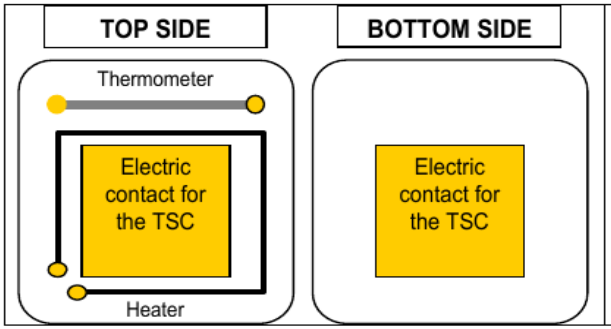
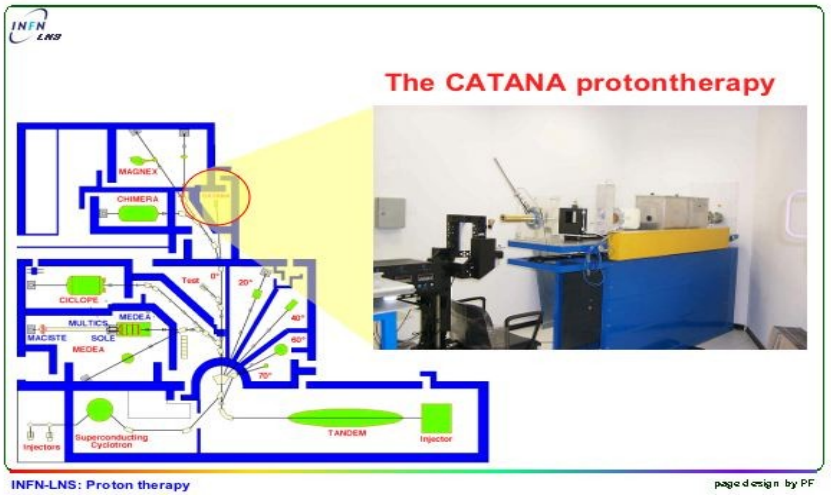


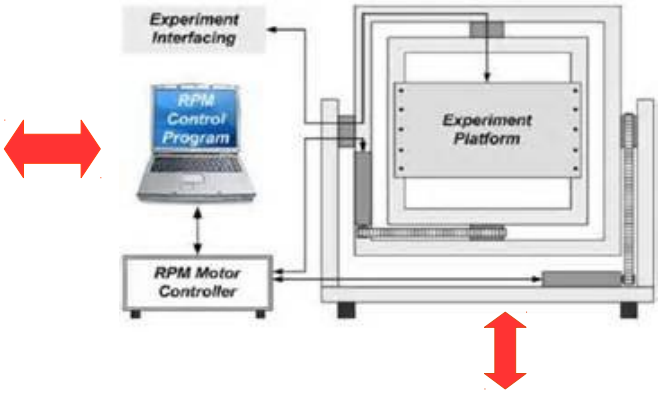
Figure 1: Scheme of the diamond PD. On the top surface an heater, a thermometer and the electric contacts for the TSC readout of the stored signal. On the bottom surface of the device the second electric contact for the TSC readout is present.

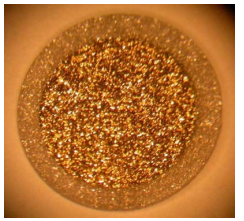
N°	Objective	Strengths	Weakness	Qualification
Low/high-LET irradiation experiments				
1	In-vivo experiments with dosimeters implantation technology:lipid metabolism	Tissue equivalence, Deciphering lipid metabolism and radiation dose and quality of radiation	Sensitivity to very low doses, Low number of mice for each experimental group and strain.	Multidisciplinary and, cell-to-cell and tissues interplay studies. Isolation of suitable molecular targets as biomarker and for countermeasure

Experiments with 3D dosimeters implantation: LNF (Prof. E. PACE)

Perspectives: MONSTRE Consortium, call “SPACE”, EU (Three years)







Diamond Dosimeter

Proton, HZE irradiation and microgravity : LNS Catania
(Prof. G. CUTTONE)

Perspectives: MONSTRE Consortium, call “SPACE”, EU (Three years)

National Institutes in the Consortium:

- ENEA, Casaccia, Roma
- Istituto Nazionale di Metrologia, ENEA, Roma
- Università La Sapienza, Roma
- Ist. Superiore di sanità, Roma
- Ist. Tumori, Genova

Intn. Institutes in the Consortium

- GSI, Helmotz Inst., Ger
- SKCN-CN, Belgium
- Atomki, Hungaria
- IMP-CAS, R.P. China
- Univ. Aberdeen, UK
- Univ. Cambridge, UK

Grazie per l'attenzione

M. Cestelli-Guidi (INFN-LNF)
R. Amendola (ENEA/INFN)

Perspectives: MONSTRE Consortium, call “SPACE”, EU (Three years)

National Institutes in the Consortium:

- ENEA, Casaccia, Roma
- Istituto Nazionale di Metrologia, ENEA, Roma
- Università La Sapienza, Roma
- Ist. Superiore di sanità, Roma
- Ist. Tumori, Genova

Grazie per l'attenzione