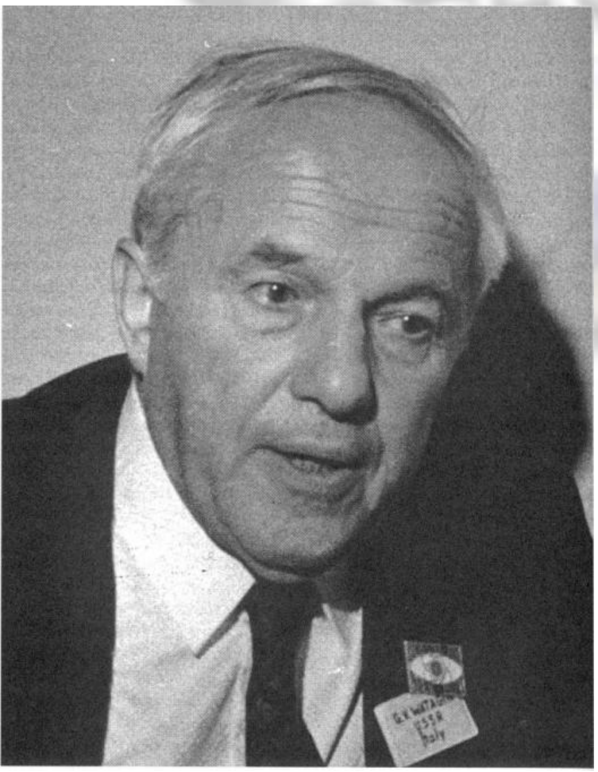
Newton C. Frateschi , PhD
Associate Director
Instituto de Física "Gleb Wataghin" - Unicamp
http://www.ifi.unicamp.br

Summary

- Introduction
- Team, Grad and Undergrad Schools
- Departments and Research
- Research “Numbers”
- Final remarks

Gleb Wataghin Physics Institute



- Named after *Prof. Gleb Wataghin*, pioneer in the establishment of experimental Physics in Brazil;
- Founded in 1967
- Several renowned scientists were invited to join UNICAMP and establish the Physics Institute;

Location


Image © 2011 GeoEye
© 2010 Inav/Geosistemas SRL
© 2010 MapLink/Tele Atlas
492 ft
Imagery Date: Jul 31, 2010
Eye alt 3710 ft
©2010 Google

TEAM, GRAD AND UNDERGRAD SCHOOLS

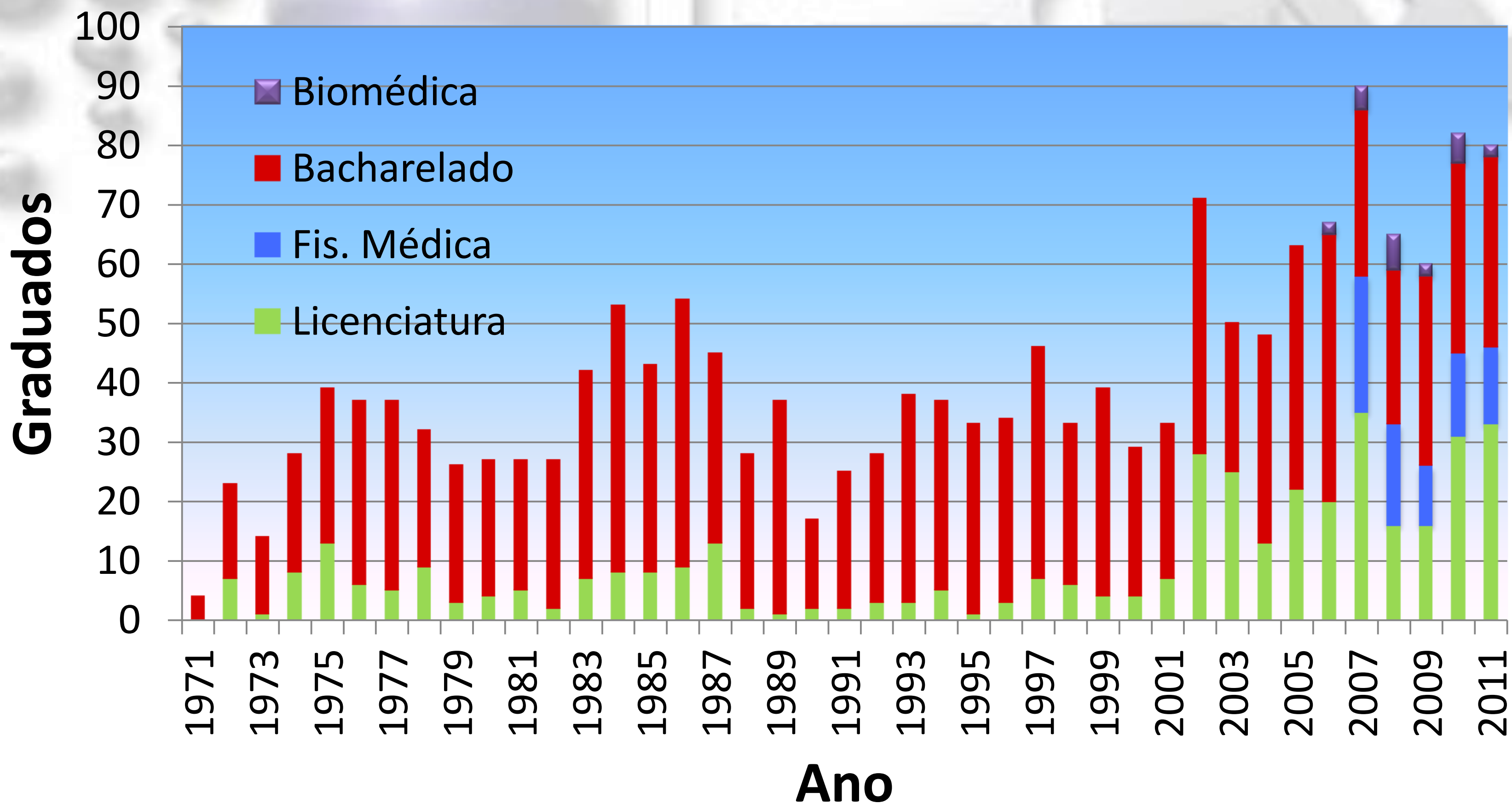
IFGW 2010

Faculty	84
Associate Faculty (collab.)	10
Research Associates	20
Staff (non-faculty)	142
Undergrad students (admitted in)	65
Grad Students (Master)	101
Grad Students (PhD)	156

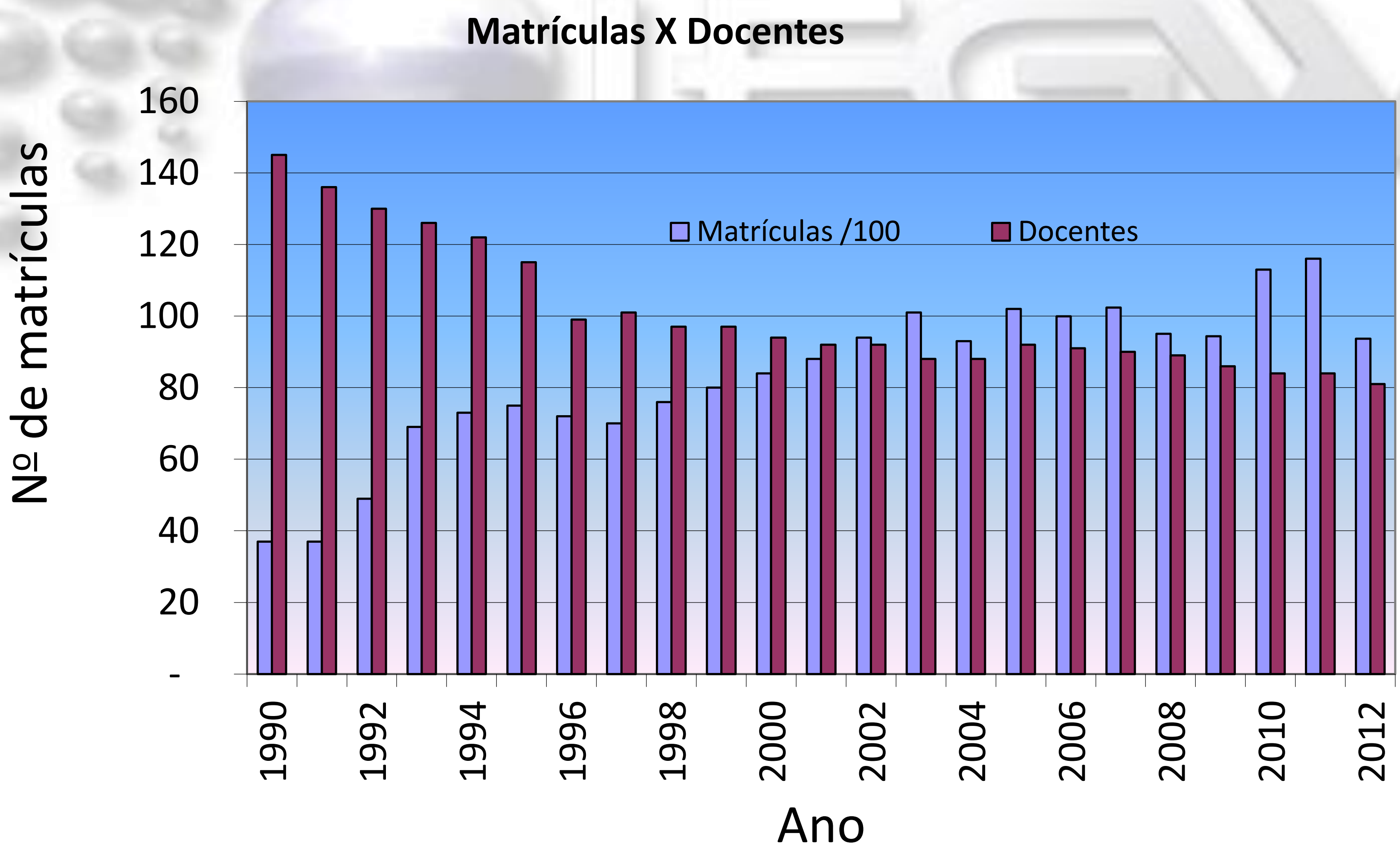
The Undergrad School

- The IFGW offers the following undergrad degrees and teaching Licenses:
- Bachelor in Physics (Day)
- Bachelor in Applied Physics (Day)
- Bachelor in Medical Physics (Day)
- Bachelor in Biomedical Physics (Day)
- Bachelor in Engineering Physics (Day) starting 2013
- Teaching License in Physics (Day or Night)

Undergraduate Students, 1971-2011



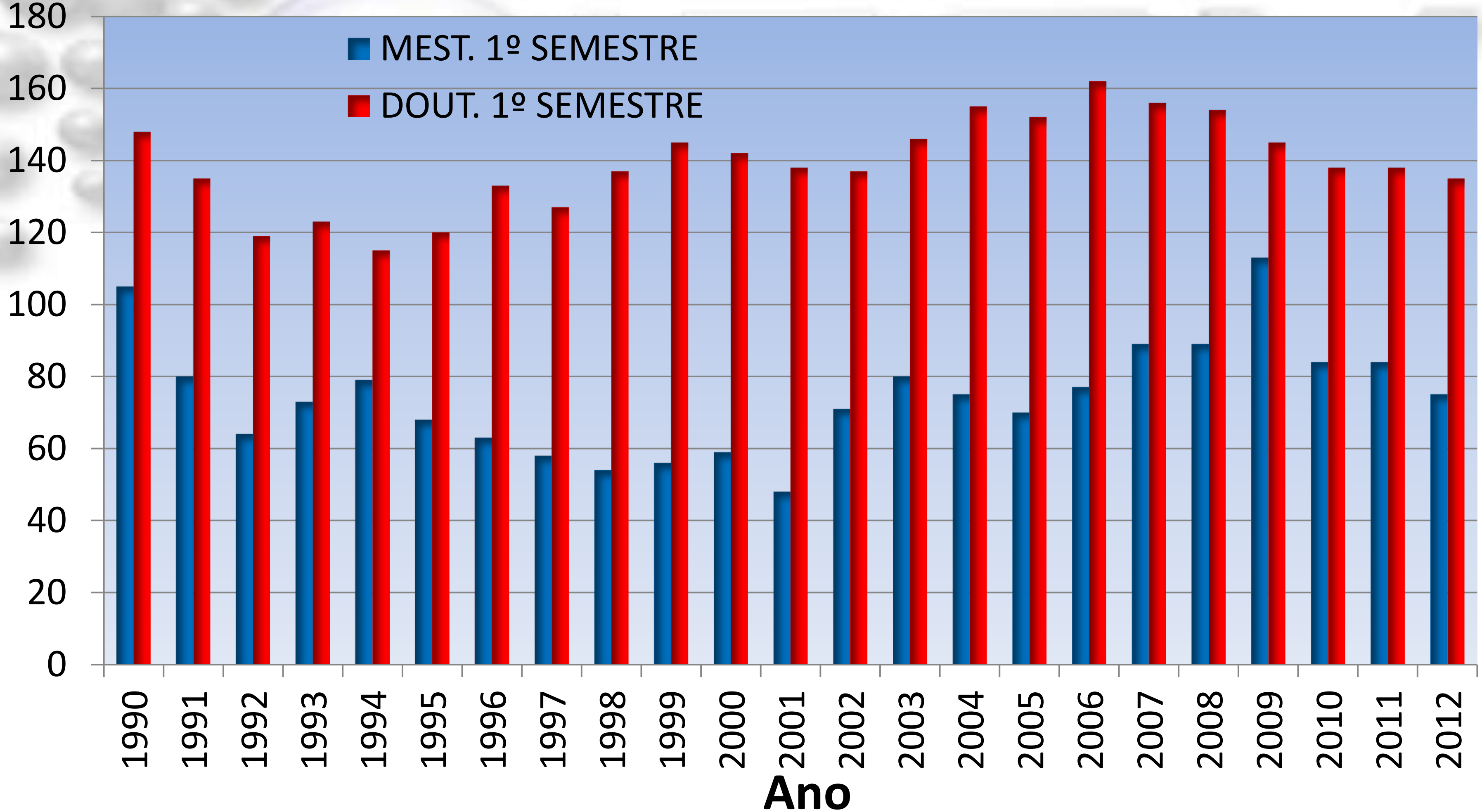
IFGW is also responsible for several courses of other Science & Technology majors.



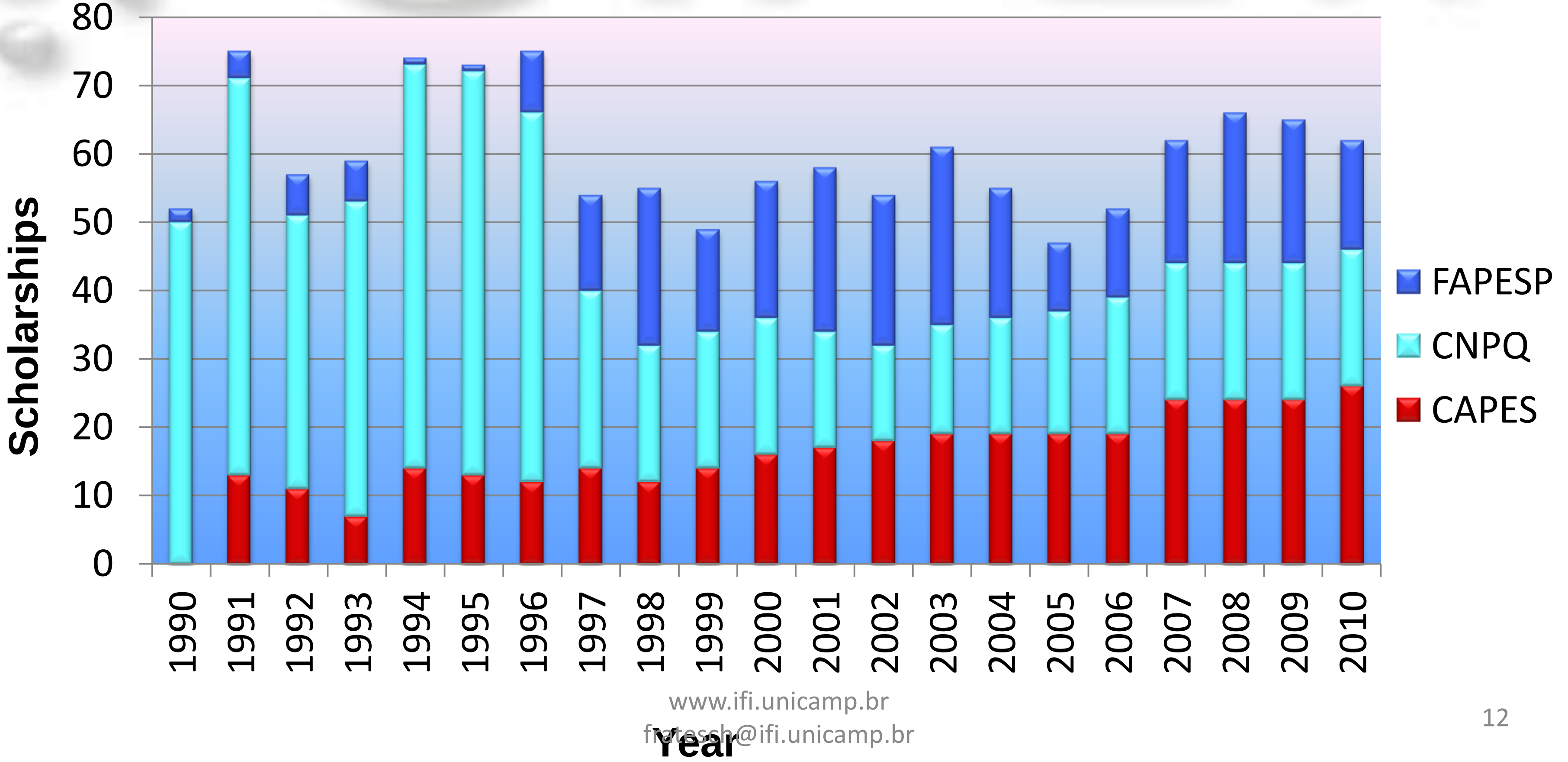
The Grad School

- Masters and PhD in Physics;
- Grade 7 (Maximum) by CAPES – Ministry of Education;

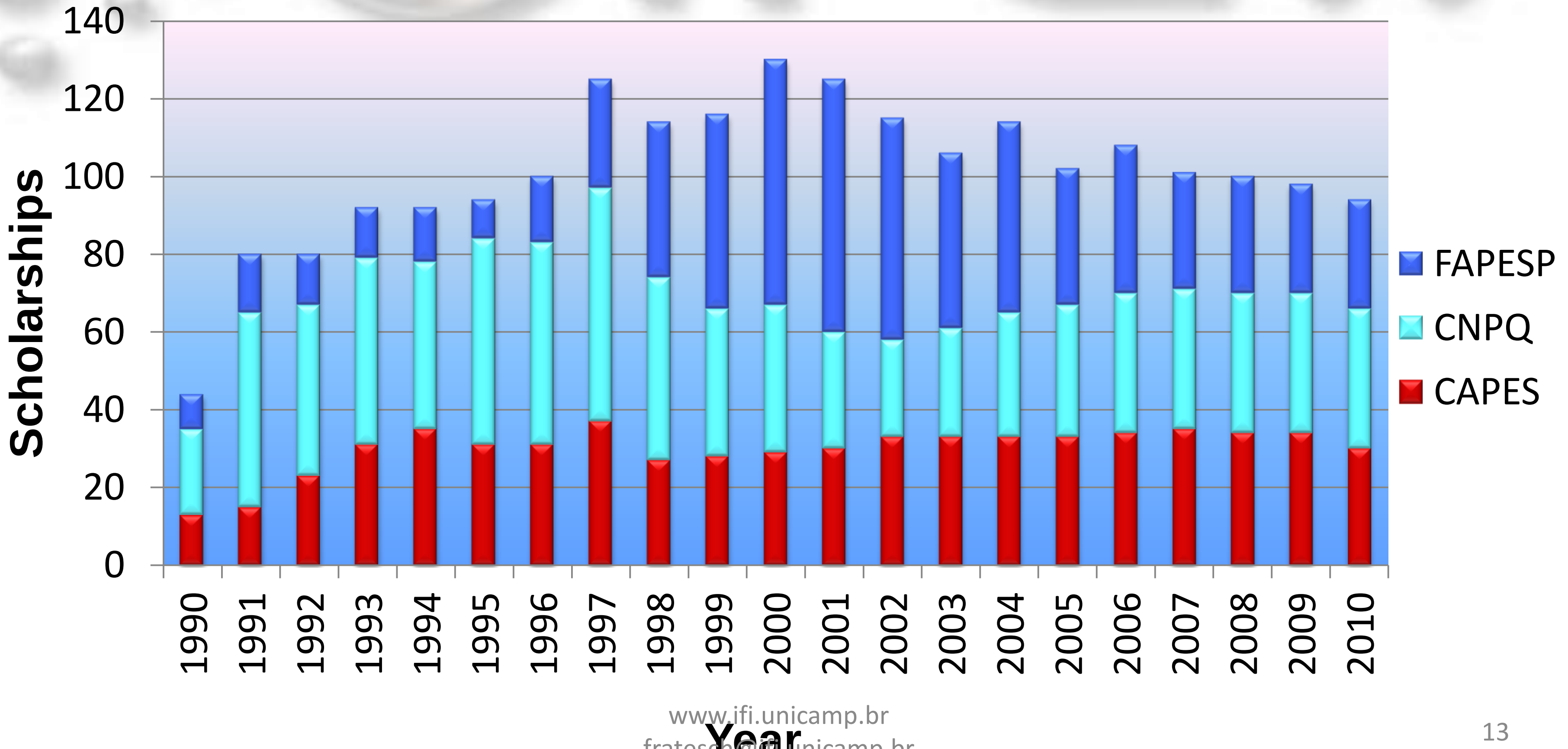
Number of Master and PhD students per year



Master's degree scholarships IFGW



PhD Scholarships IFGW



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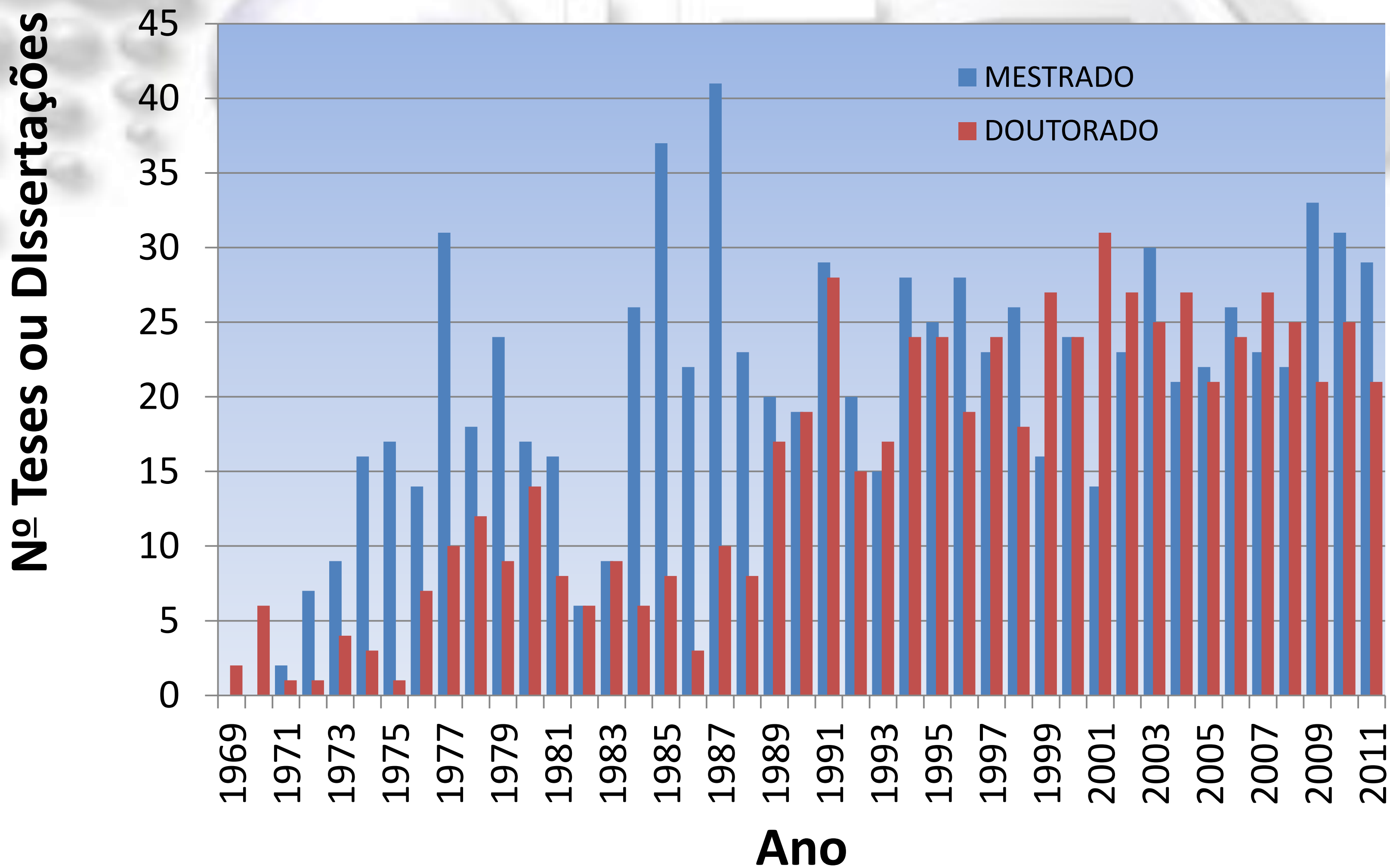
Number of Ms dissertations and PhD thesis.



Summary

1967 - 2011

Undergrad	**1. 687**
Bachelors	1.245
Licensed	355
Medical/Biomedical Physics	87
Master’s degree dissertation	**882**
PhD thesis	**658**

DEPARTMENTS AND RESEARCH

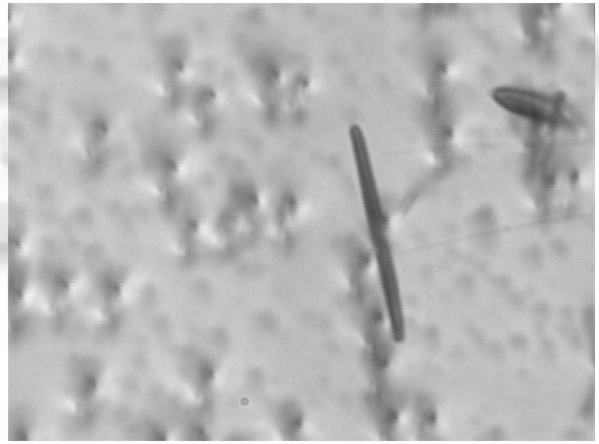
The IFGW has four departments:

- **Cosmic Ray and Chronology**
- **Physics of the Condensed Matter**
- **Quantum Electronics**
- **Applied Physics**

Cosmic Rays and Chronology

- Founded by Prof. Cesar Lattes with emphasis in Cosmic Ray Science;
- 16 faculty;
- Research groups:
  - Chronology
  - Emulsions
  - Leptons
  - History and Theory of Science
  - Neurophysics
  - Neutrino Physics and Astrophysics
  - Theoretical Physics

Chronology



- Started with uranium dating 1972.
- Interest:
  - Fission Track Thermochronology in crystals;
  - Defects and healing over geological periods;
- Highlight:
  - Development of a powerful model for building the thermal history of rocks (different minerals)

Emulsion

- Brazil-Japan Collaboration involving several researchers
- Interest:
  - Cosmic Rays rare events

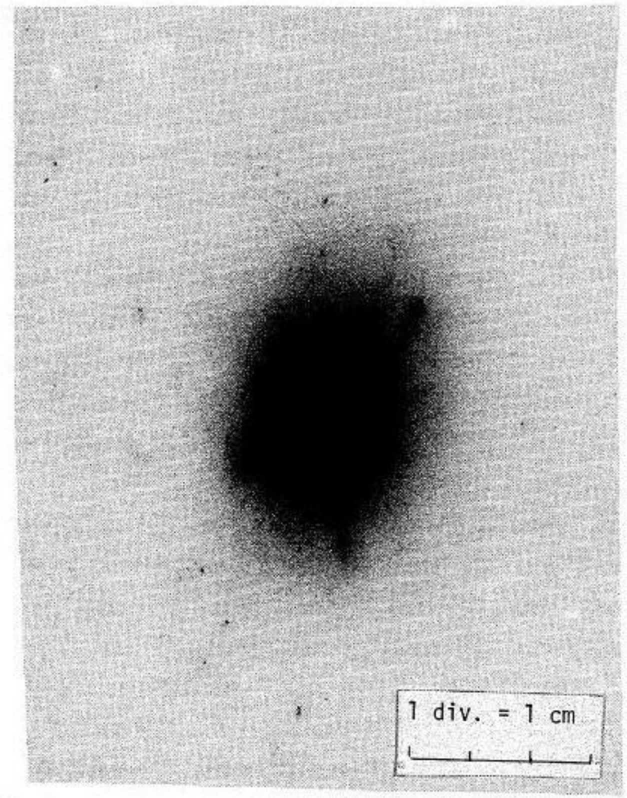


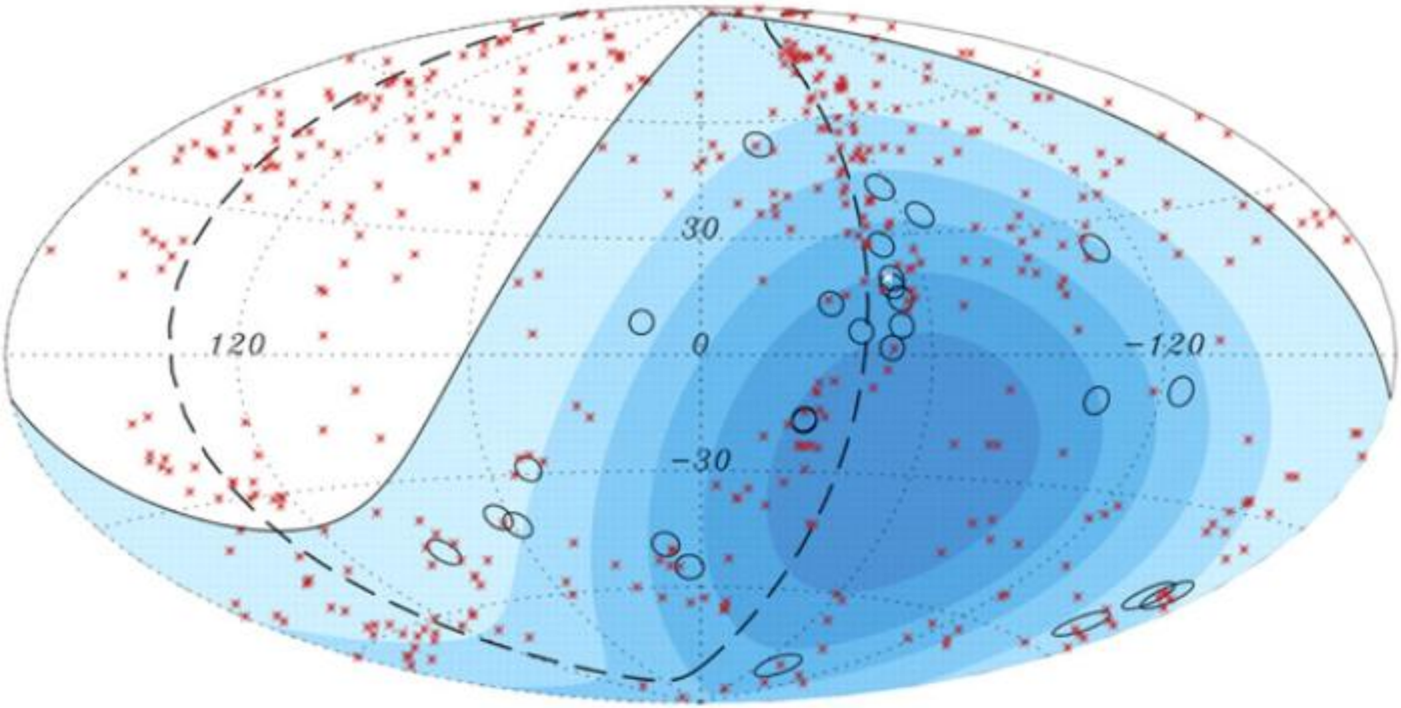
Fig. 1. A photograph of central part of M.A. III, observed on the N-type X-ray film located at 10 c.u. in the chamber, where total electron number of halo reaches the maximum.

JPSJ-54-529

Leptons

- High Energy Experimental Physics:
- High energy Cosmic Rays (Pierre Auger Observatory)
- Relativistic Heavy ions Collisions (RHIC and ALICE)
- Neutrino Oscillation(MINOS, Double Chooz and AngraNu)
- Charm Mesons Production (SELEX)
- Kaons charge parity violation Measurement (KTEV)

Highlight :
Correlation between
Active galactic nucleus ★
and Auger from high energy cosmic rays ○



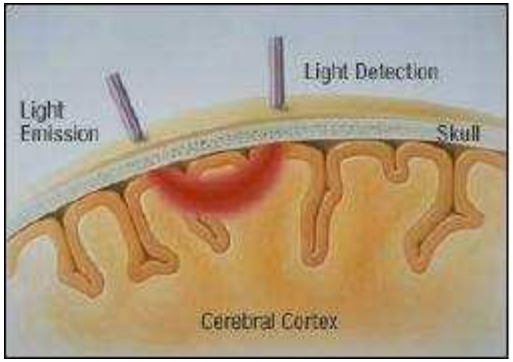
Neurophysics

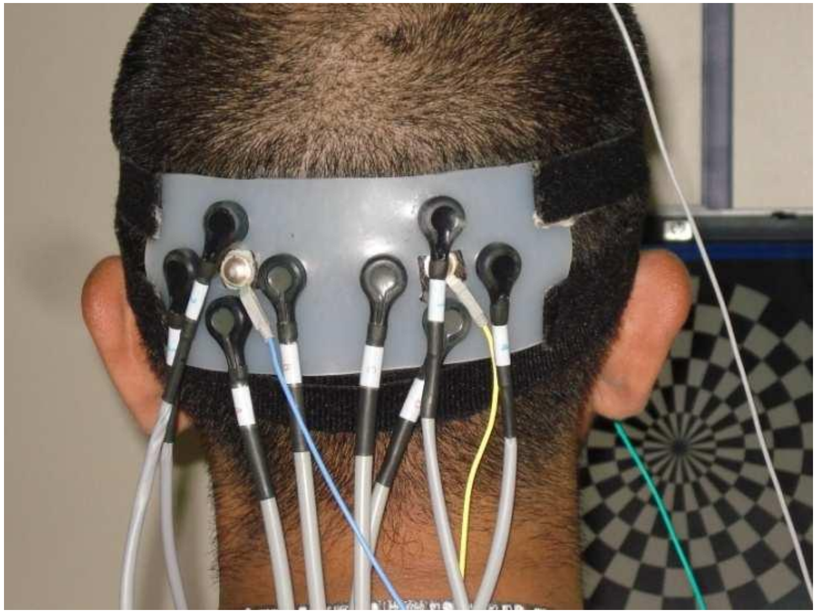
The Biophysical and neurological basis of functional brain images by:

Magnetic resonance

Optical tomography

electroencephalography





Physics of the Condensed Matter

31Faculty
15 Staff (Technical and Administrative)
Groups:

Theorectical

- ***Many body systems***
- ***Dynamical systems***
- ***Structural and electronic properties of metals and semiconductors***
- ***Computing modeling in Condensed Matter***
- ***Semiconductor Heterostructures***
- ***Statistical Mechanics of Dissipative systems***
- ***Electronic Properties from first principle Calculation***
- ***Magnetic and Thermal properties of condensed systems***
- ***Electronic properties of new materials***

Experimental

- ***Applied Crystallography and X-rays***
- ***Materials and Low temperature***
- ***Optics***
- ***Optical Properties***
- ***Ion implantation in metals***

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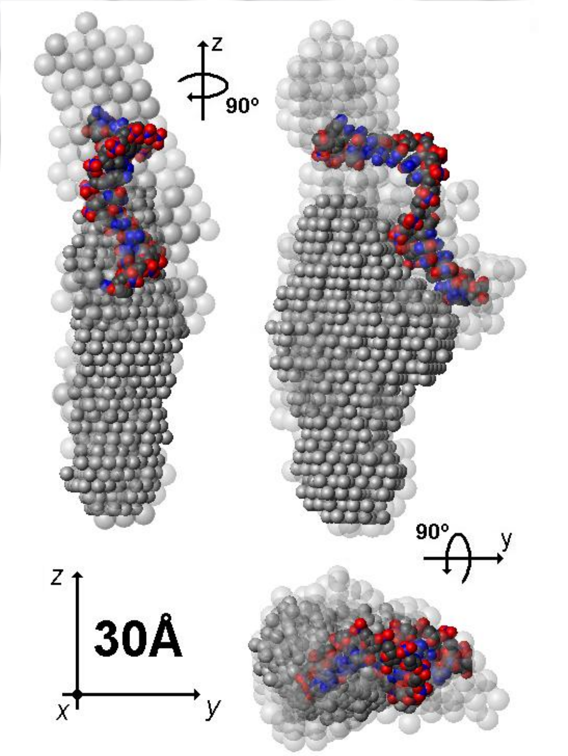
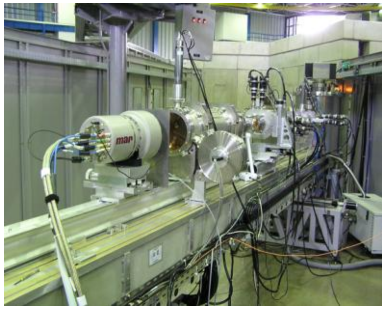
Applied Crystallography and X-rays

Research Areas:

- Semi-crystalline/amorphous polymer blends
- Conjugated conducting polymers
- Biological Macromolecules
- Nanostructured Materials



Strong Interaction with LNLS (Development of two lines for shallow angle scattering)



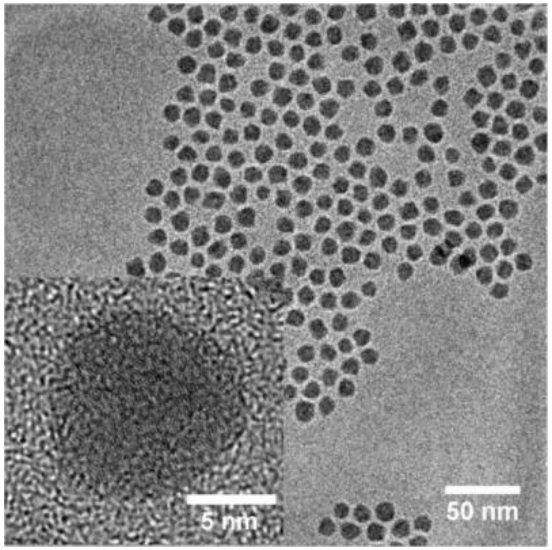
First structural evidence of the Prion Protein *(DNA role in infection process)*

Materials and Low temperature

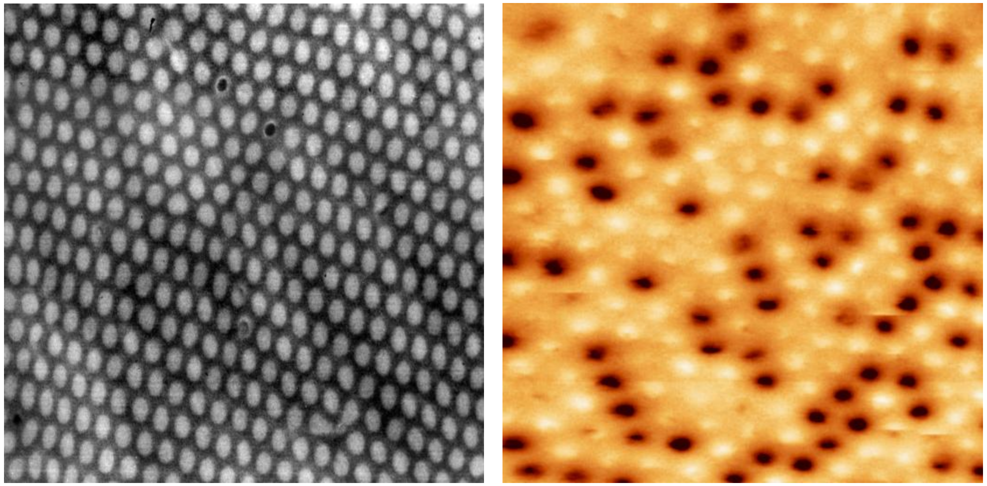
Complete set-up for low temperature/magnetic characterization

Research Areas:

- *superconductors,*
- *Amorphous and nano-crystalline metals*
- *Artificial magnetic materials*



Synthesis and analysis of nanoparticles of ferrites and transition metal oxides



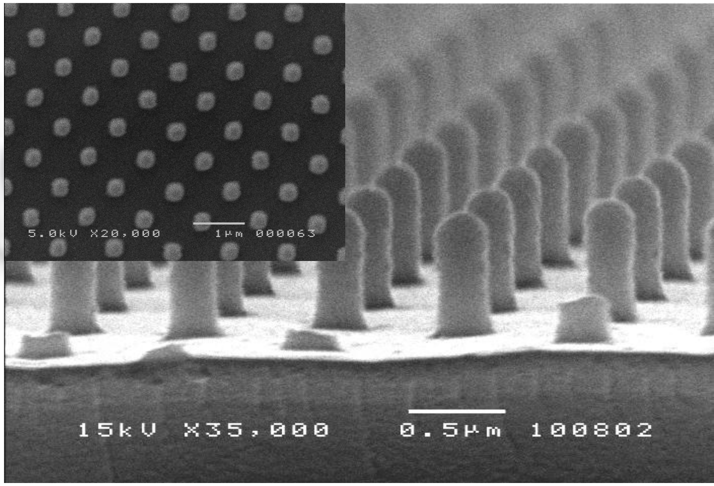
SEM and Magnetic force image of Ni nanowires

Optics

Research Areas:

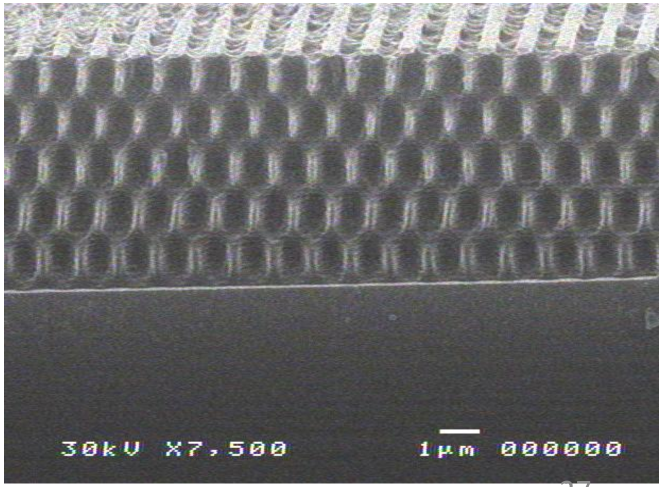
- *Basic and Applied research in optics and optical metrology*
- *Holography and 3D imaging*
- *Optoelectronic devices*
- *Photorefractive materials*
- *Interferometric holography*

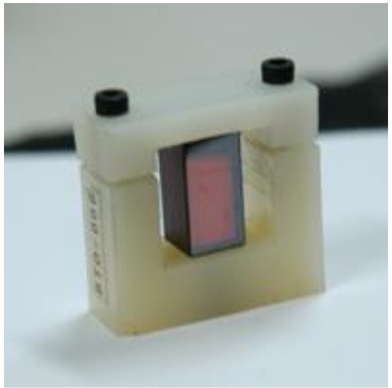
2D



Photonic Crystal fabrication and Characterization

3D





Photorefractive materials

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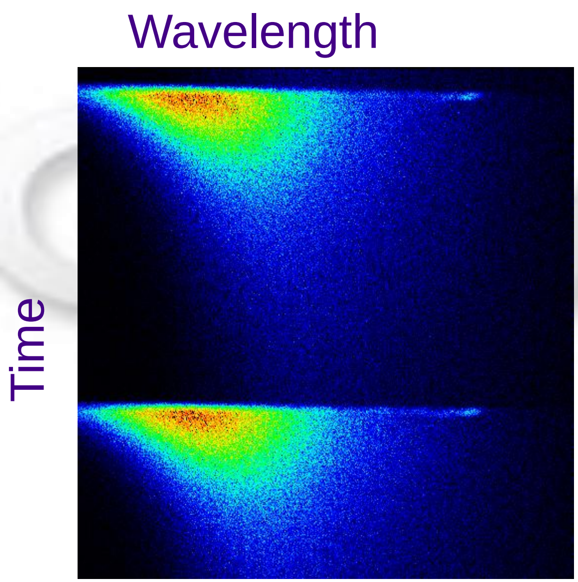
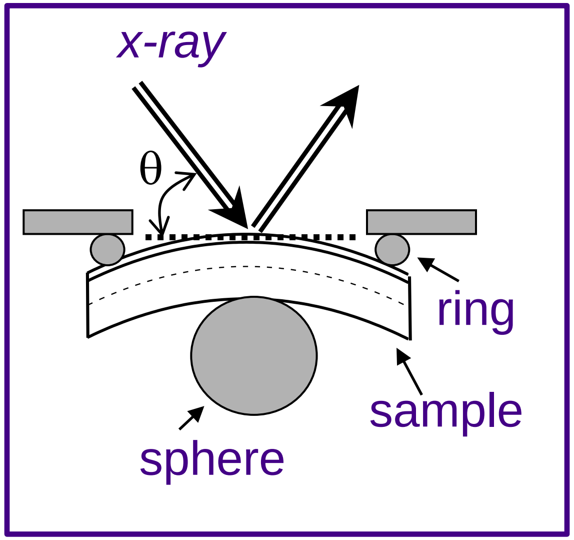
Optical Properties

Research Areas:

- *Optical and electrical properties of low dimension structures of semiconductor and semi-magnetic materials.*



Time resolved luminesnce
dynamics of electron transport



X-Ray (LNLS) diffraction under biaxial pressure

"Exciton g-factor of type-II single quantum dots"
Phys. Rev. B , **73**, 033309 (2006)

Ion implantation in Metals

Research Areas:

- *Ionic nitridation based on new pulsed plasma technology*
- *(In collaboration with de Applied Physics Department)*

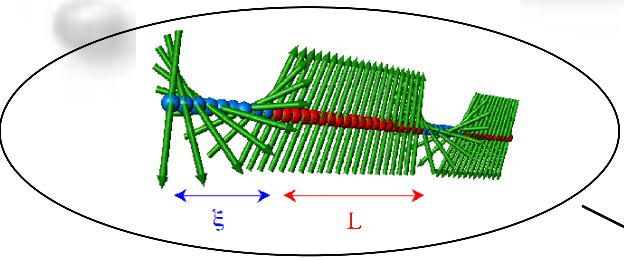
Gears in furnace for surface treatment

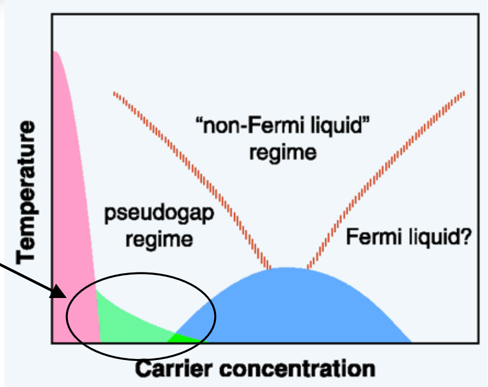
Physics of many body systems

Research Areas:

- *Dynamics of non-isolated systems*
- *Strong correlation electronic systems*

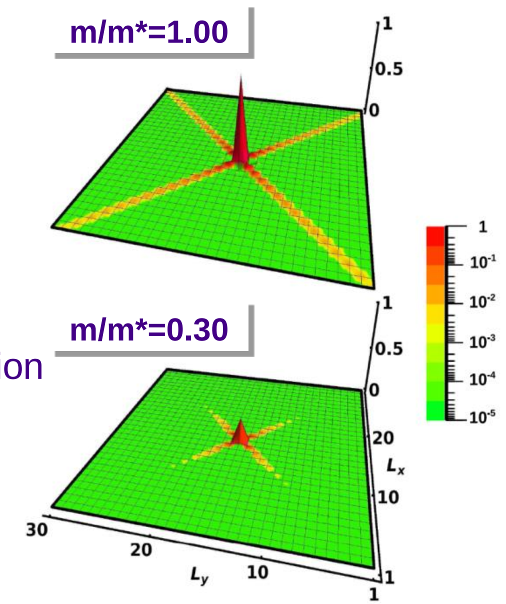
INCT for Quantum Information





$\delta n_i = n_i - 1$

Friedel suppression near Mott metal – insulator transition



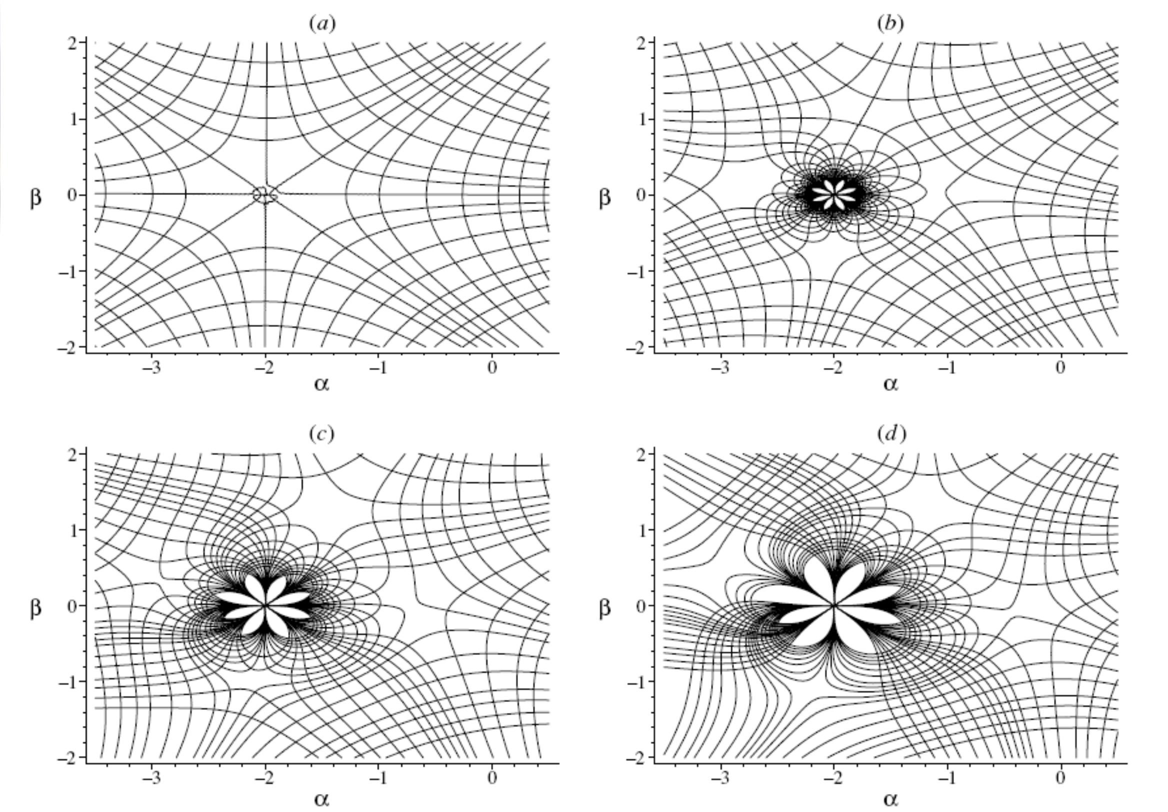
L=30, ε_o=-D=4t

"Dynamics of topological defects in a spiral: a scenario for the spin-glass phase of cuprates"
Phys. Rev. Letters 92 (2004) 137202

"Quantum ripples in strongly correlated metals"
Phys. Rev. Lett. ***104****, 236401 (2010).*

Research Areas:

- *Chaos in classical and quantum systems*



Dynamics of chaotic systems with spin and tunneling.

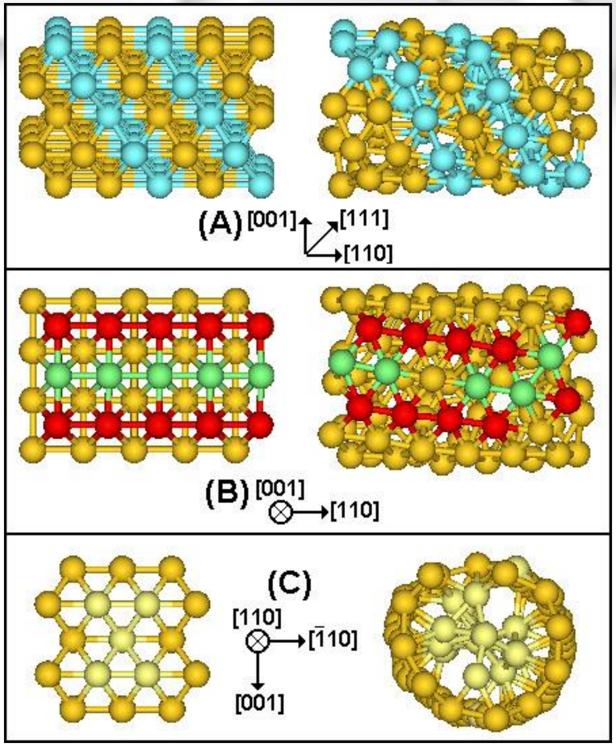
Phase Space; system with $1/x^2$ barrier and singularity at $x = 0$

Research Areas:

- *Structural and electronic properties of complex and nanostructured materials.*

Computing modeling in Condensed Matter

The mechanism of helicoidal Au nanowires formation



Quantum Electronics

- 22 faculty;
- Research groups:
  - Optics and Photonics:
    - Lasers and Applications
    - Quantum Optics
    - Bio-photonics
    - Ultra fast phenomena and optical communication
  - Condensed Matter:
    - Photothermics and magnetic resonance
    - Optical and magnetic properties of solids
  - Plasma Physics
  - Atomic and Molecular Physics

Highlights

- Center for Optics and Photonics: CePOF UNICAMP (with the Applied Physics Department)
- INCT Photonics for telecommunication (with the Applied Physics Department)
- Projects on strong correlation Systems under extreme conditions

Highlights

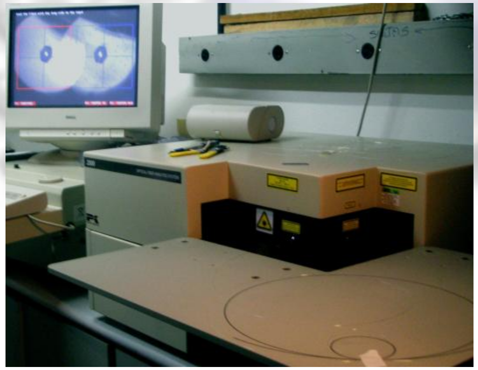
Optical Communications Laboratory

•Optical Spectrum Analyzers (down to 1MHz
•resolution BW)
•Oscilloscopes (up to 50 GHz BW)
•Bit Error Ratio Tester (up to 10 Gbps)
•320 Gbs DWDM system (home-made)
•Connected to KyaTera testbed (50 fibers on
•wall)
•Web access to all instruments

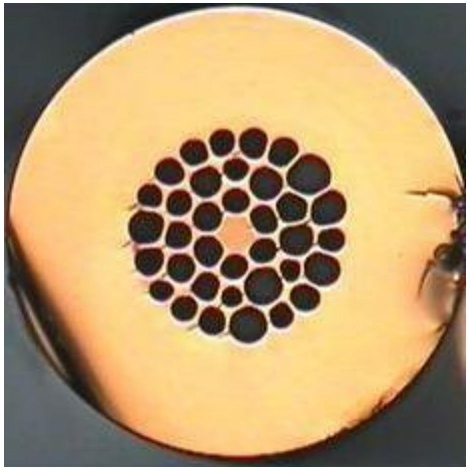
Specialized in Nonlinear Fiber-Optics and High Capacity Systems

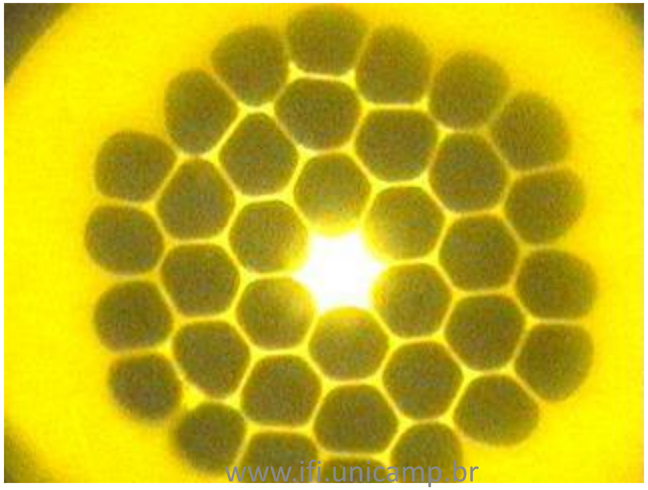
Highlights

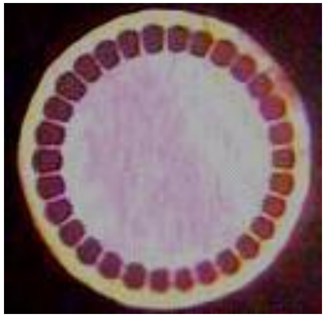
Optical Fiber Fabrication

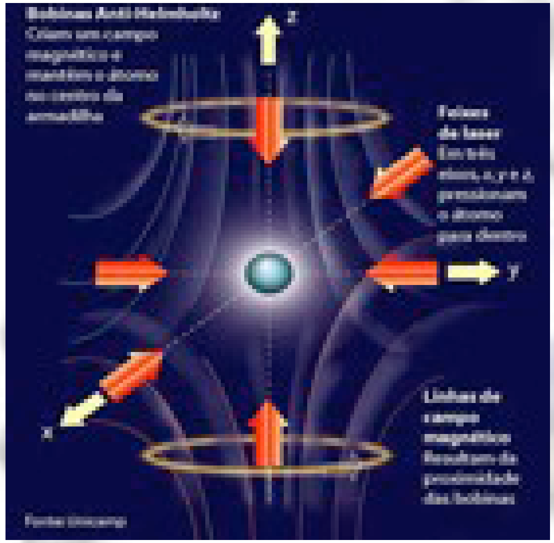


- Special glass fibers (tellurite, niobate, silica…)
- Photonic crystal fibers
- Polymer fibers
- Rare earth doped fibers
- Optical, physical and chemical characterization
- Laser ablation system



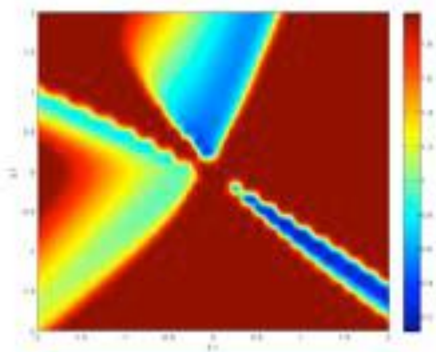






Highlights

Laser Applications



- Laser trapping and cooling
- Atomic clock
- Non-linear optics, frequency comb generation
- non-linear spectroscopy
- Special lasers: femtosecond, Terahertz

Applied Physics

- 30 faculty;
- 24 staff
- Research groups:
  - Alternative Fuels
  - Photovoltaic research
  - Surface Physics
  - Hydrogen
  - Device Research Laboratory
  - Nano and Bio systems
  - Materials and devices
  - Nano-structures and Interfaces
  - Organic Solids and New Materials
  - X- ray diffraction
  - Statistical Physics and Complex Fluids
  - Physics of Nano-systems and Nano-structured Materials
  - Materials preparation and characterization
  - Complex Fluid Statistics
  - Diluted Nano Systems

Overview

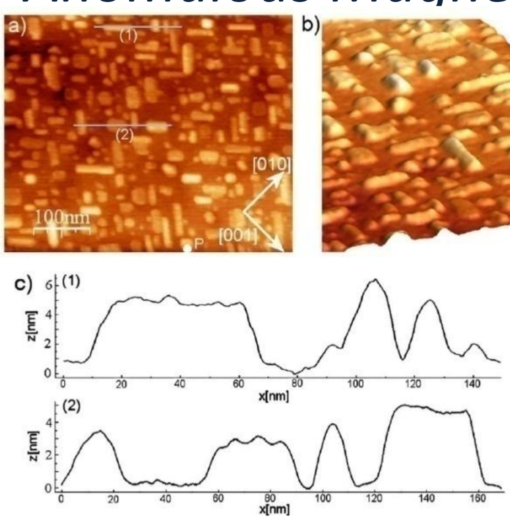
- Experimental:
  - Energy
  - Optoelectronics/Photonics
  - Materials and interfaces
  - Instrumentation
  - Medical Physics
- Theory
  - Molecular and electronic structure
  - Statistical Physics and complex fluids

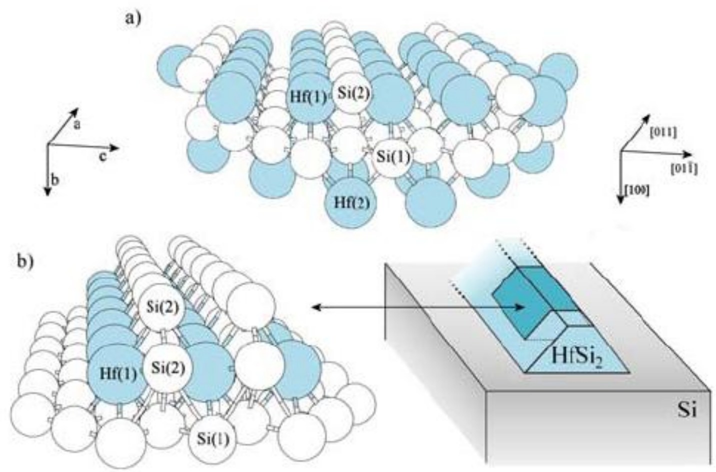
NANO!

Research Areas:

Electron spectroscopy (XPS, UPS, AES, XPD, STM) to obtain the electronic/crystalline structure and the composition of metals, alloys and supported catalyst.

- *Surface Metallic alloys*
- *Supported Metallic Oxides*
- *High k materials*
- *Anomalous Magnetic Materials*

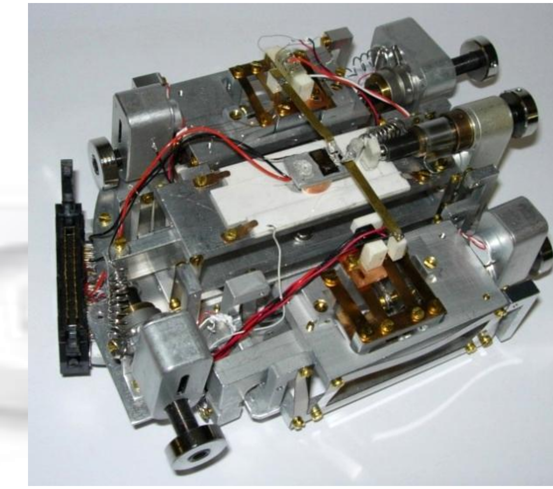


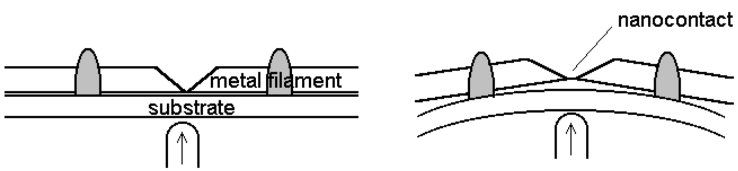


Surface structure of $HfSi_2$ nanorods´s on Si(100)

Research Areas:

- Techniques for the controlled synthesis and characterization of nano-systems
- Instrumentation development/optimization for the nano-manipulation of nano-systems.;





Room Temp.

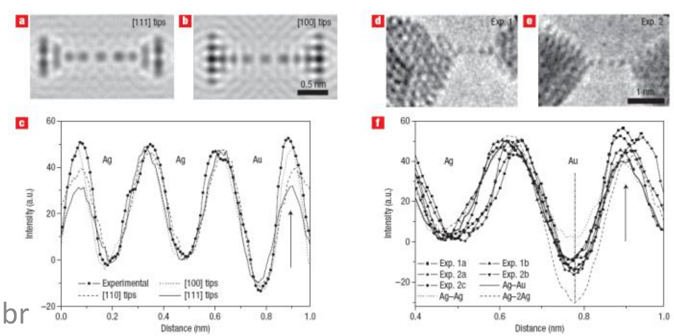
UHV $<10^{-10}$ mbar

LETTERS

Experimental realization of suspended atomic chains composed of different atomic species

J. BETTINI[1], F. SATO[2], P. Z. COURA[3], S. O. DANTAS[3], D. S. GALVÃO[2]* AND D. UGARTE[1,2]

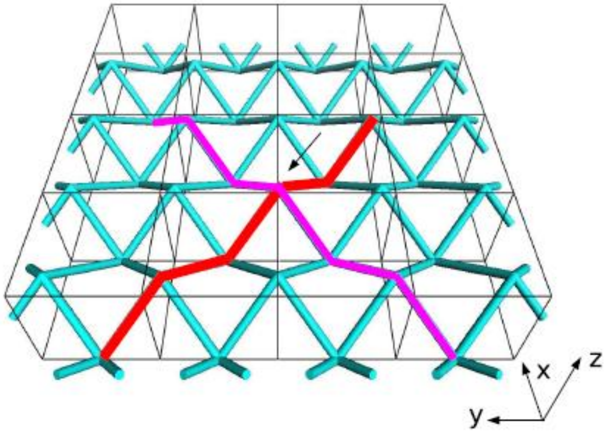
[1]Laboratório Nacional de Luz Síncrotron, CP 6192,13084-971 Campinas, Sao Paulo, Brazil
[2]Instituto de Física Gleb Wataghin, Universidade Estadual de Campinas, CP 6165, 13083-970 Campinas, Sao Paulo, Brazil
[3]Departamento de Física, ICE, Universidade Federal de Juiz de Fora, 36036-330 Juiz de Fora, Minas Gerais, Brazil
*e-mail: galvao@ifi.unicamp.br



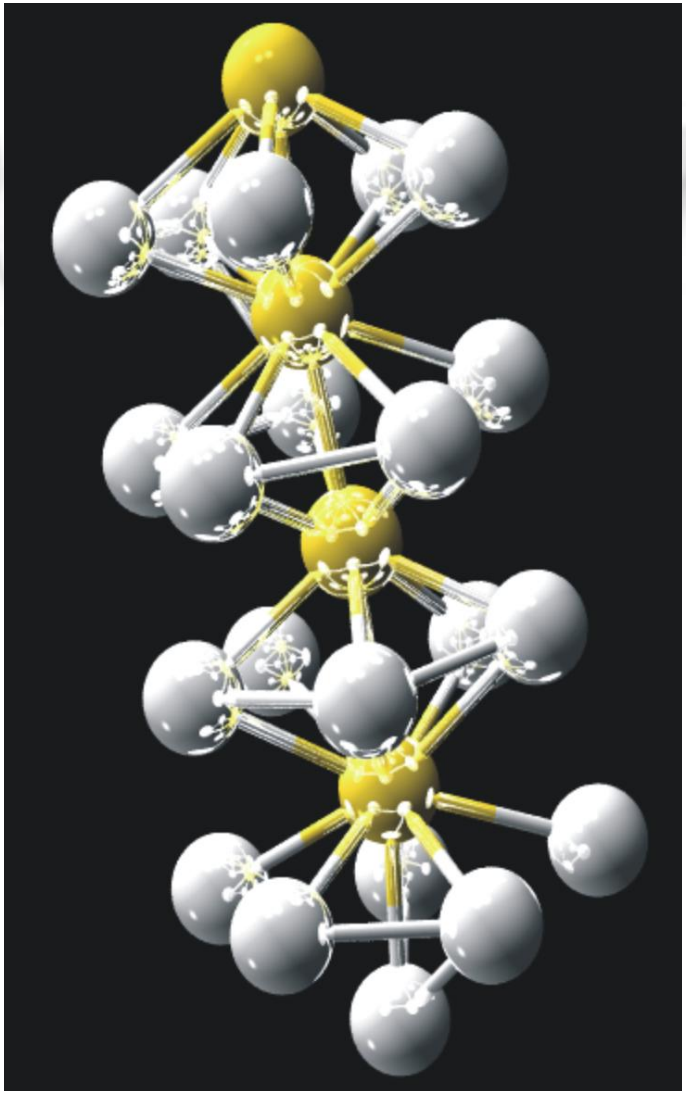
Structural and Quantum Conductance Properties of Atomic-size Metal Nanowires

Research Areas:

•Electronic Structure of conducting polymers;
•Electronic Structure of carcinogenic molecules and medicine;
•Molecular Structures; Metal; Alloys; bio-nanotecnology.



Science v320, 504 (2008)



Nature Nanotechnology v1, 182 (2006)

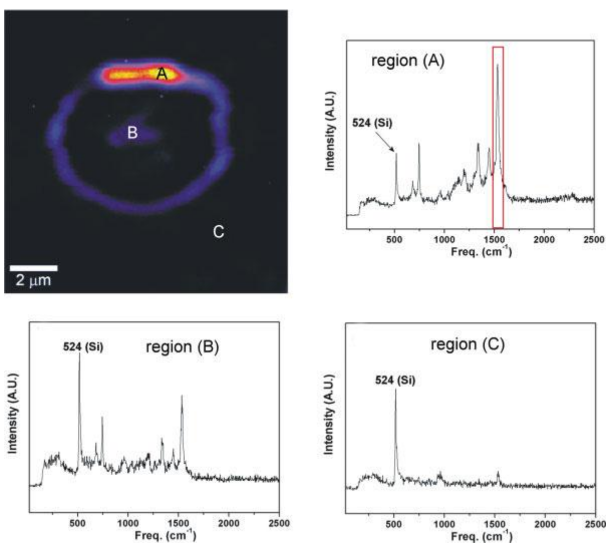
Research Areas:

- Advanced Carbon Material (fullerene and nanotube);
- Energy Projects;
- Co-generation in the tertiary sector:
  - Burning residues from agricultural production;
  - Compaction and residue treatment;
  - Fast hydropyrolysis;

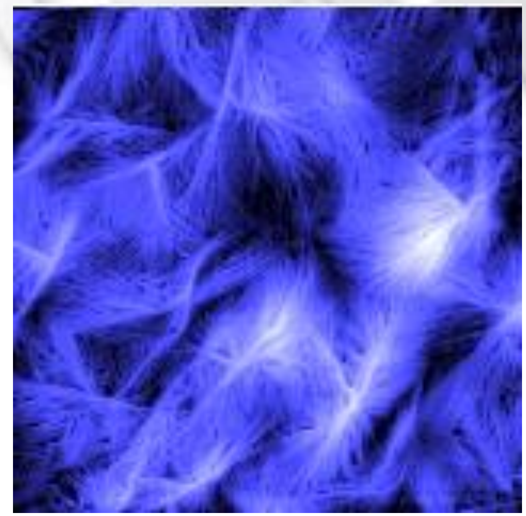
Nanostructures and Interfaces

Research Areas:

- Solid-liquid and solid-solid interfaces;
- Selective etching;
- DNA structure
- Liposome;
- Electrochemistry and bio-electrochemistry
- Sensors



Quorum Sensing Detected by Atomic Force Microscopy



Nanotexturized Polytetrafluoroethylene Substrates Formed by Large Crystalline Nanofibrils in Amorphous Matrices

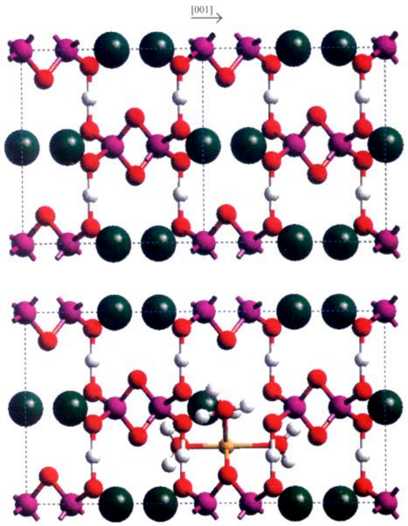
Source: Journal of Nanoscience and Nanotechnology, Volume 8, Number 4, April 2008 , pp. 2135-2142(8)

X-ray Diffraction

Research Areas:

•Multiple X-ray diffraction study of semiconductor and organic crystals under electric fields;
•Ion implanted semiconductor;
•New material characterization
•Crystalline structures at interfaces;

EXAFS + Molecular Modeling



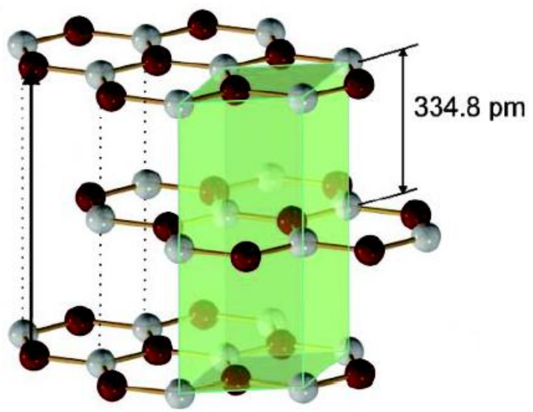
Pure KDP

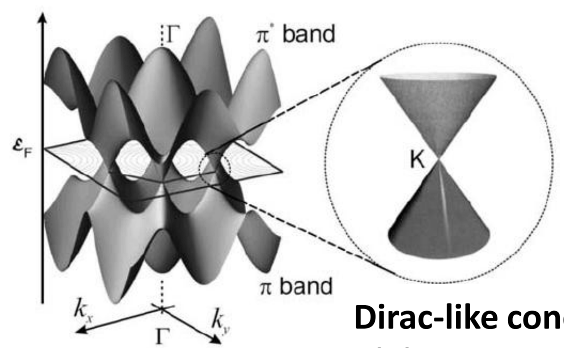
(001) →

Lai, Roberts, Bedzyk, Lyman, Cardoso & Sasaki, Chemistry of Materials (2005) **17**(16), 4053

Research Areas:

•Electrical and Magnetic properties of Carbon based materials: graphite, fullerene, graphene, etc.
•High temperature superconducting and ferromagnetic correlation
•Quantum Hall effect and Dirac fermions;



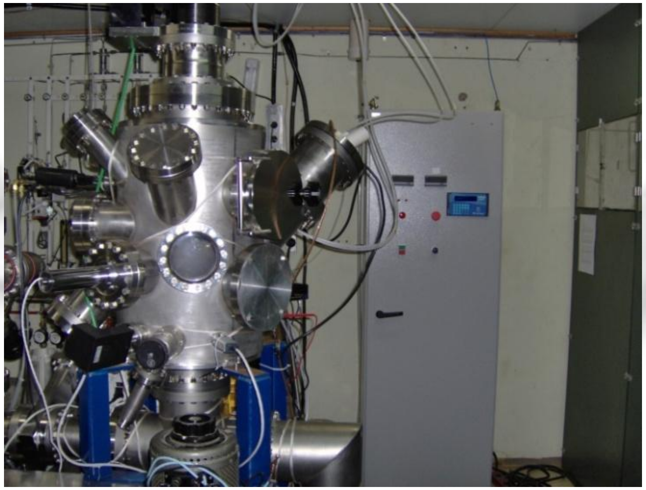


Dirac-like cone spectrum:
$E(p) = \pm vp$; $v = t_{||}a/\hbar$, $v \cong 10^6$ m/s

"First direct observation of Dirac fermions in graphite", **Nature Physics 2, 595 (2006). Before the graphene boom**

Research Areas:

- Material for photovoltaic conversion, microelectronics;
- Optical properties of thin films;
- Nanostructured films
- Carbon nanotubes and fullerene with nitrogen;
- Amorphous material with rare earths for photonics;
- Metal treatment with ions;

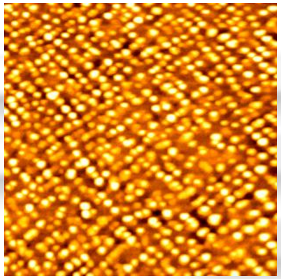


Filtered Cathodic Vacuum Arc

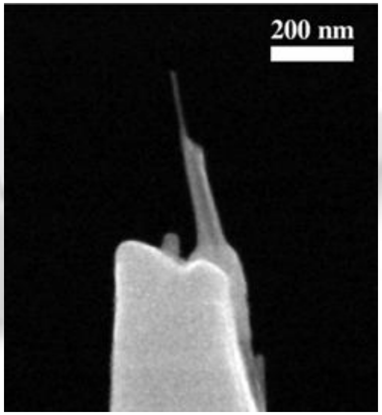
Nitretação a plasma pulsado

Research Areas:

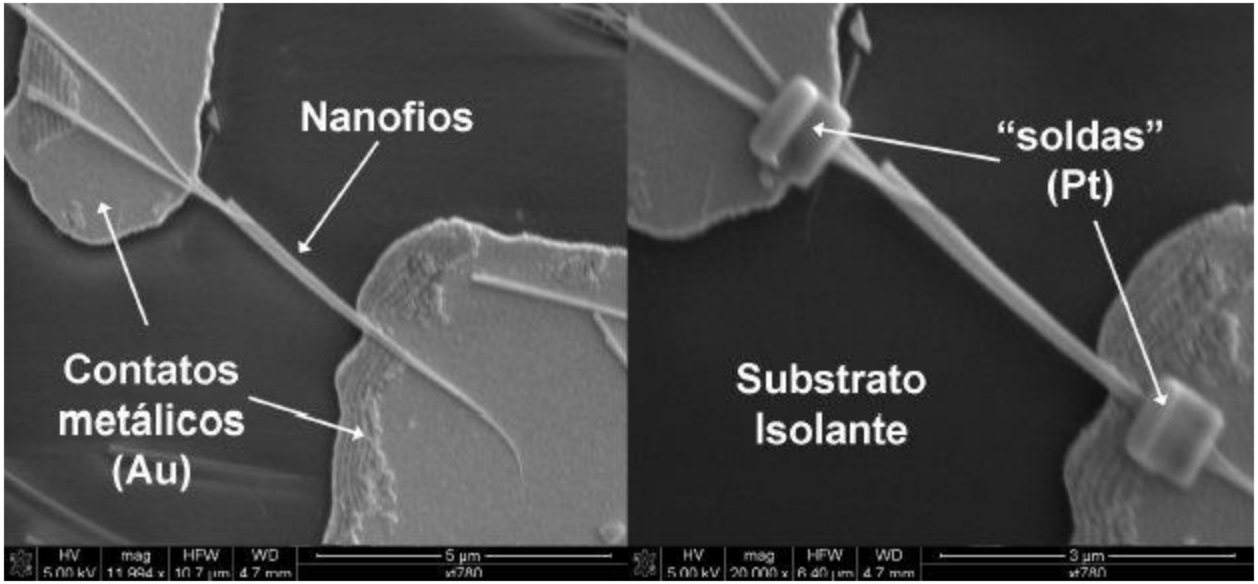
- Chemical Beam Epitaxy (In, Ga, As, P)
- Synthesis, structural and electrical properties of semiconductor nano-objects;
- Atomic Force Microscopy applied to nanomaterials and biology
- Biosensors



InAs/GaAs/InP QDs array



MWNT tip covered with a-C



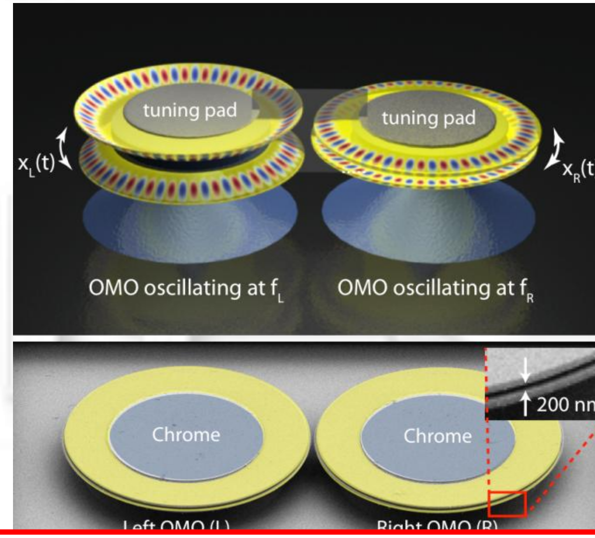
Er- doped amorphous silicon PBG suspended structures

Active microressonators

Research Areas:

- Physics, design, fabrication and characterization of electronic, photonic, and optoelectronic devices;

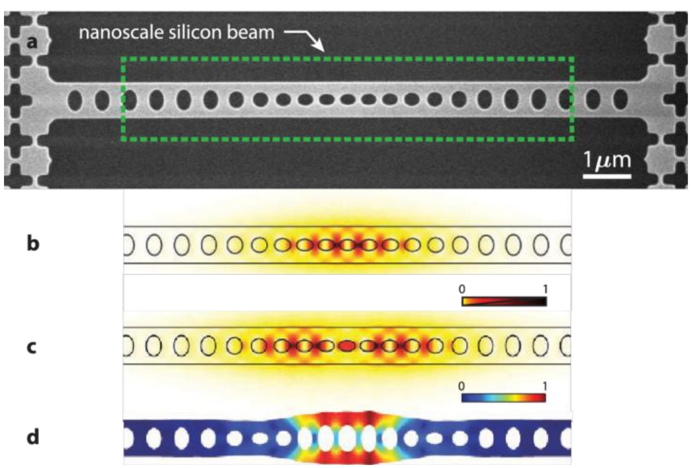
Complete clean-room for micro and nanofabrication

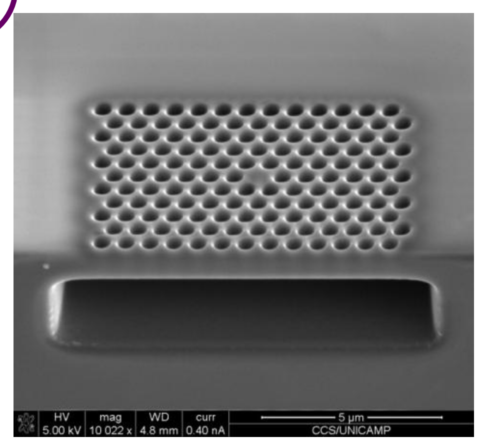


Opto-mechanical synchronization

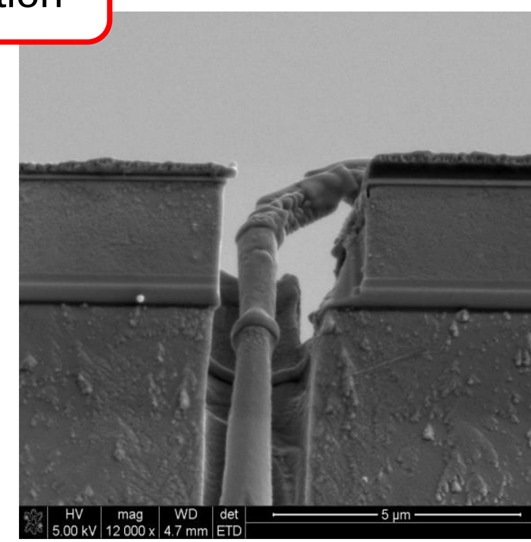
Microlasers on-chip
Light-matter interaction
Optical amplifiers
Bistability
Nanolasers
Micromechanical
Lasers

Optomechanics in nano optical cavity
Cooling mesoscopic phonons





Er- doped amorphous silicon PBG suspended structures



Active microressonators

Hydrogen

Research Areas:

- H_2 production from hydrocarcon;
- Renewable sources and distributed generation;
- H_2 Production and purification from biomass;
- H_2 production by electrolysis;
- Fuel cells for automotive application;

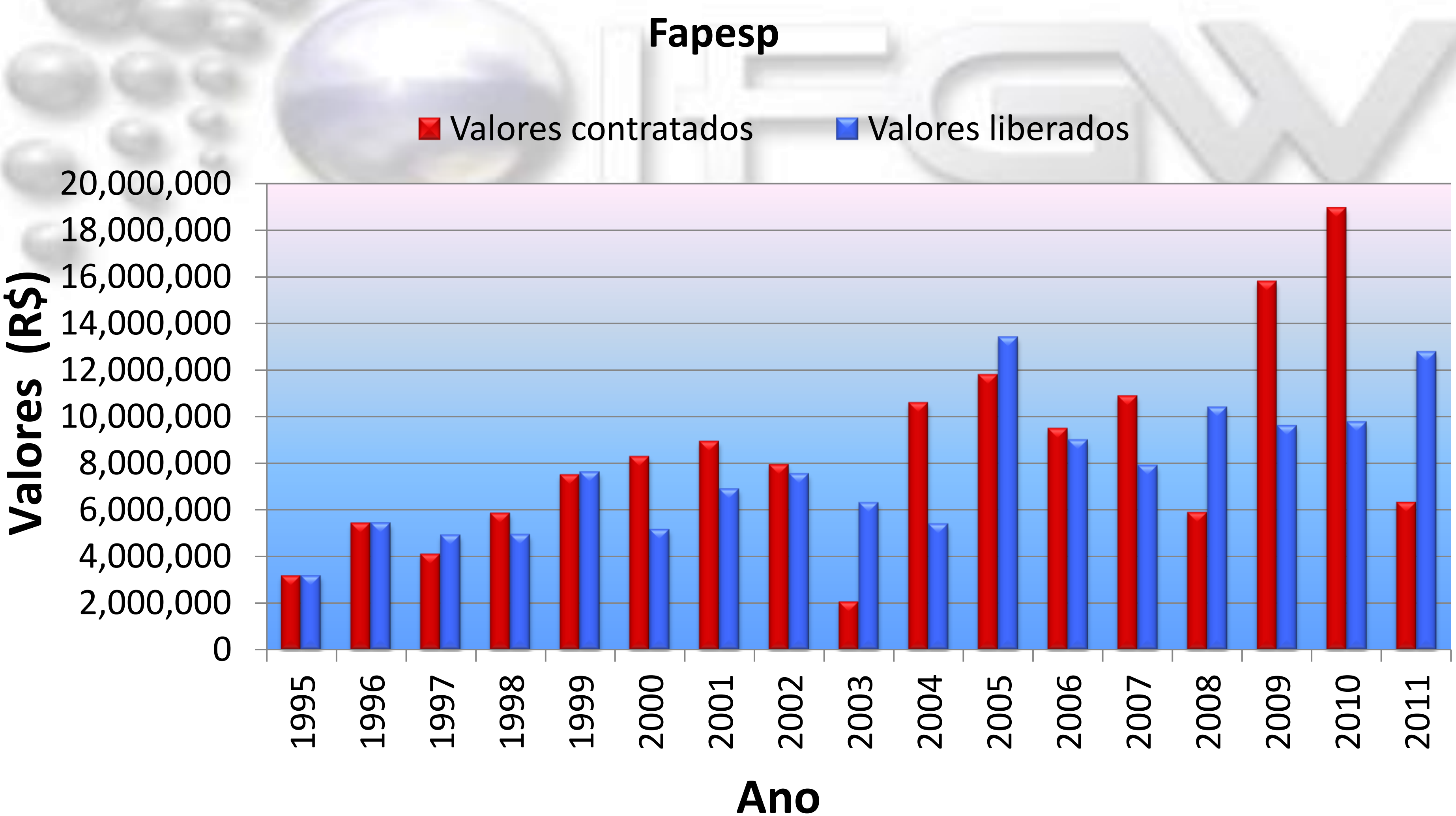
Gaseificação de biomassa

Eletrolisador CEMIG

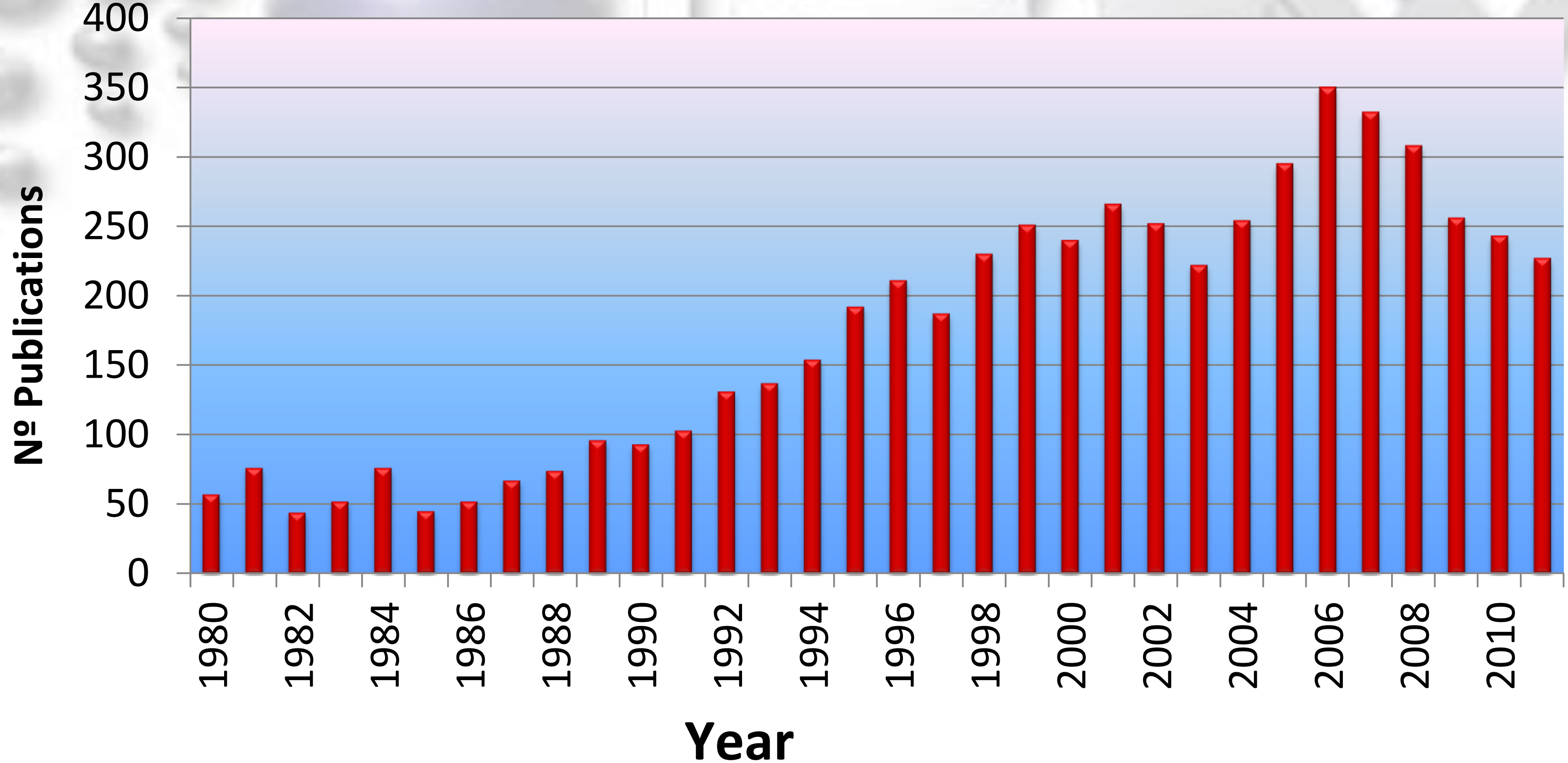
Projeto VEGA

RESEARCH “NUMBERS”

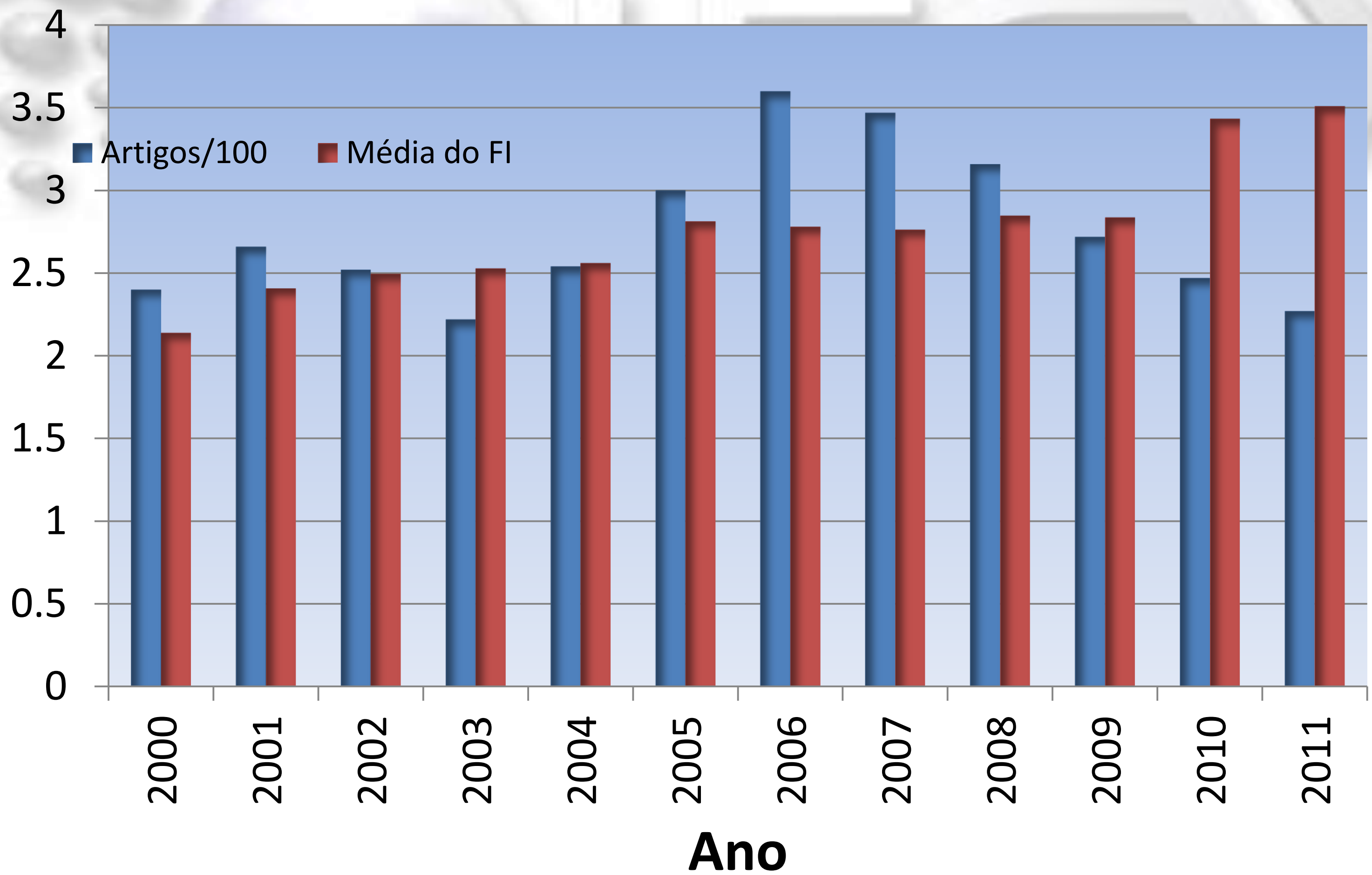
FAPEPS Funding



Number of publications (ISI) by year over the years



IFGW Publications – Average Impact factor (ISI-Web of Science)



Final remarks

- IFGW is an institute of excellence where research and education increases human knowledge and benefits society.
- There are many opportunities for carrying high level research in basic as well as applied research;
- Do contact the departments and professors for more information: www.ifi.unicamp.br
- Thank you!