SLOVAK ACADEMY OF SCIENCES

# Institute of Experimental Physics SAS, Watsonova 47, Košice


Established on : 1.1.1969

Three original physical branches:

- Cosmic rays
- Magnetism
- High energy physics

http://www.saske.sk/Uef/

# Institute of Experimental Physics SAS, Watsonova 47, Košice

Directors of the Institute:

- Juraj Dubinský, 1-st director, until 1980
- Vladimír Hajko, 1980 - 1986
- Michal Seman, 1986 - 1990
- Peter Kopčanský, 1990 - 2007
- Karol Flachbart, from 1.5.2007

# Institute Management

Till 1.5.2007:

| | |
|---|---|
| director: | P.Kopčanský |
| deputy: | K.Flachbart |
| scientific secretary: | I.Králik |
| head of scientific board: | M.Timko/K.Kudela |

From 1.5.2007:

| | |
|---|---|
| director: | K.Flachbart |
| deputy: | K.Csach |
| scientific secretary: | J.Ferencei |
| head of scientific board: | K.Kudela |

# Departments of IEP SAS

- Department of Space Physics
- Department of Subnuclear Physics
- Department of Magnetism
- Department of Low Temperature Physics
- Department of Metal Physics
- Department of Biophysics
- Department of Theoretical Physics
- Computing group
- Library

# IEP SAS Košice campus

## Main Institute building in Watsonova st. Nr. 47

Departments:

- Secretary
- Subnucl.phys.
- Theor.physics
- Metal physics
- Magnetism
- Library

## Bulharská st. Nr. 2-4-6

Departments:

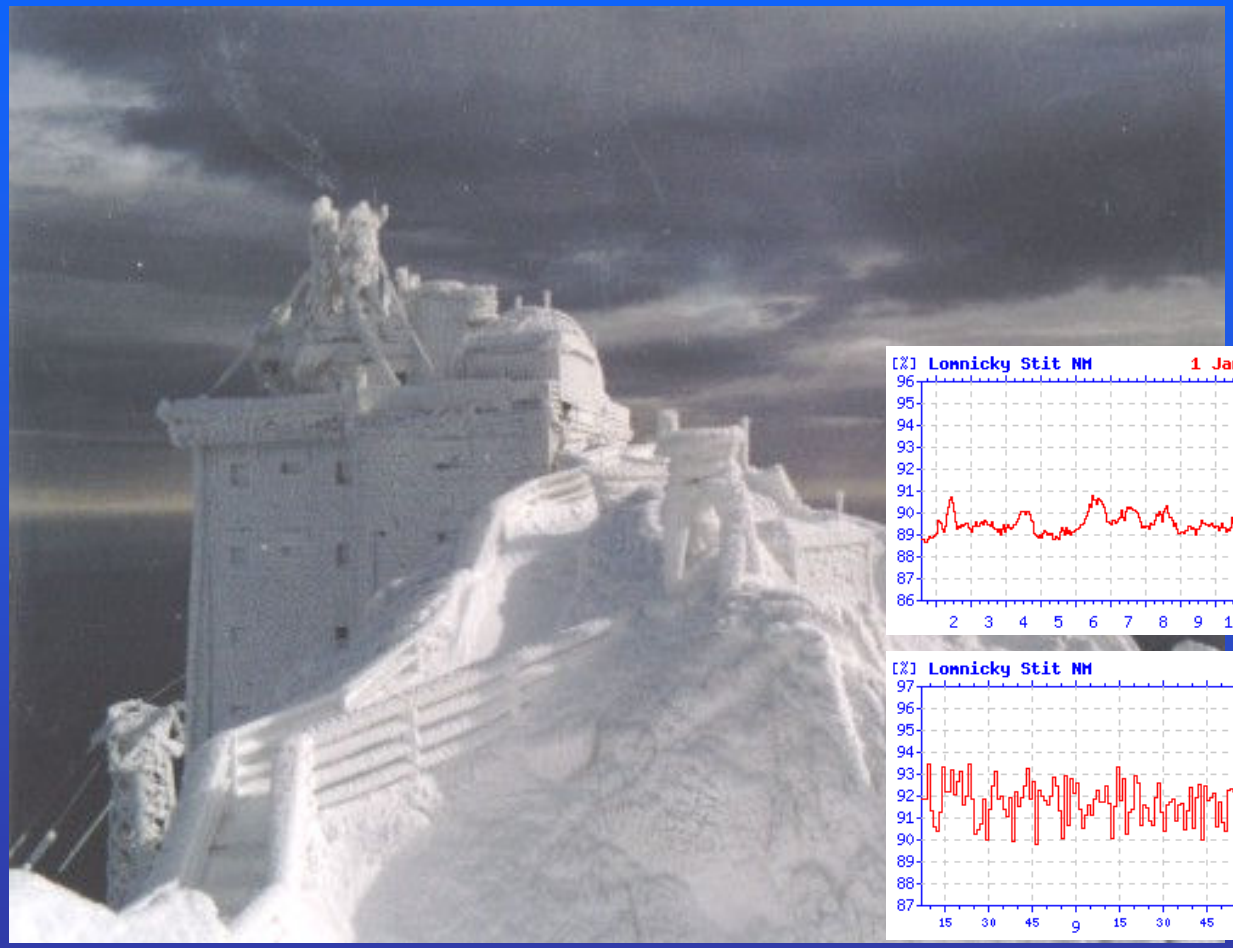
- Biophysics
- Space.phys
- Mechanical workshop

## Building at Park Angelinum 9/ Jesenná st.

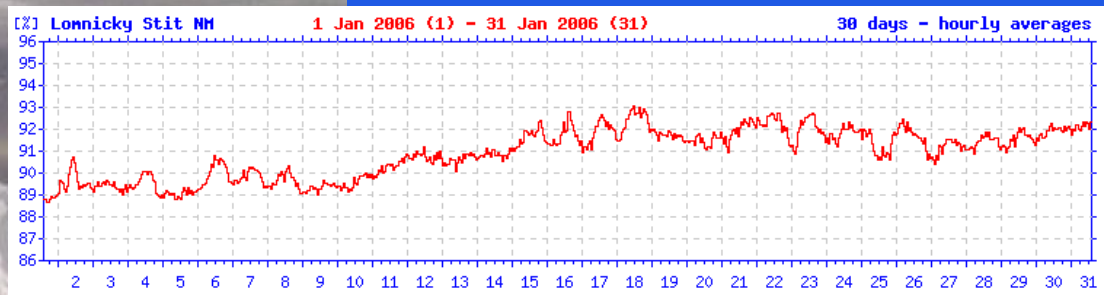
Departments:

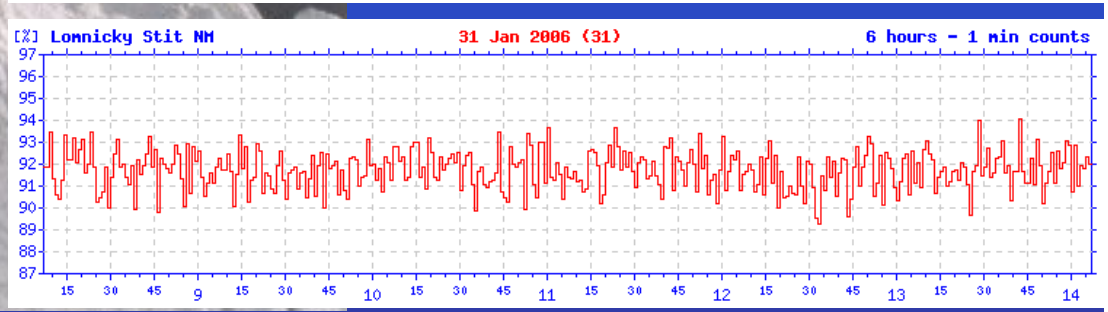
- Low temp.physics
- Magnetism ( partially)

# IEP SAS Laboratory at Lomnický Štít



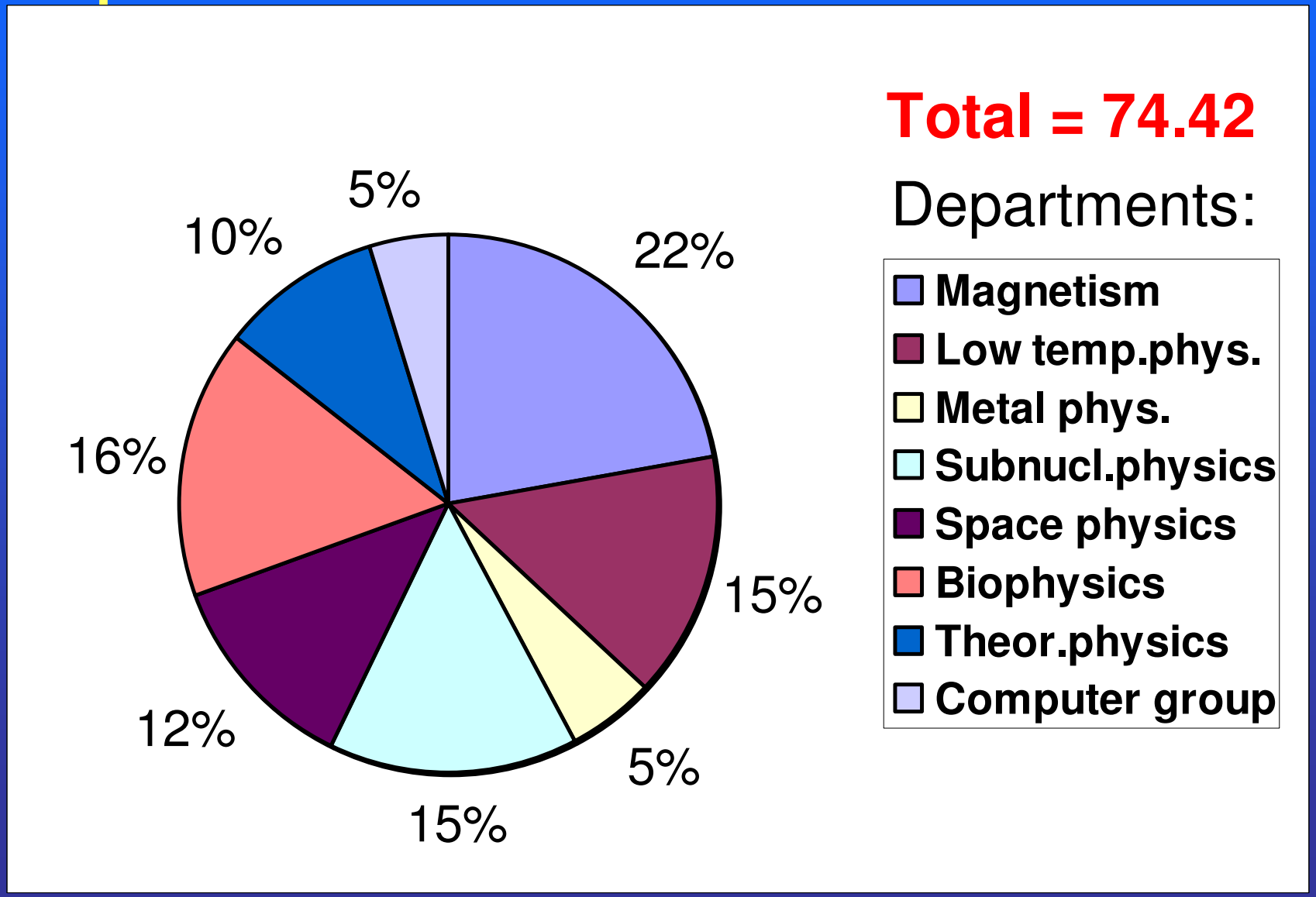
## Department of Space physics



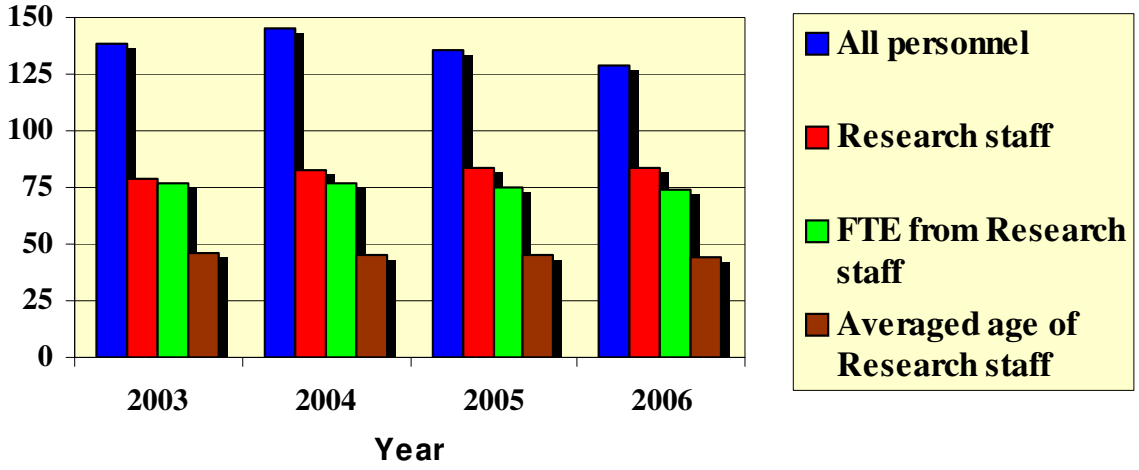




Neutron monitor at Lomnický Štít delivers data in real time available at http://neutronmonitor.ta3.sk

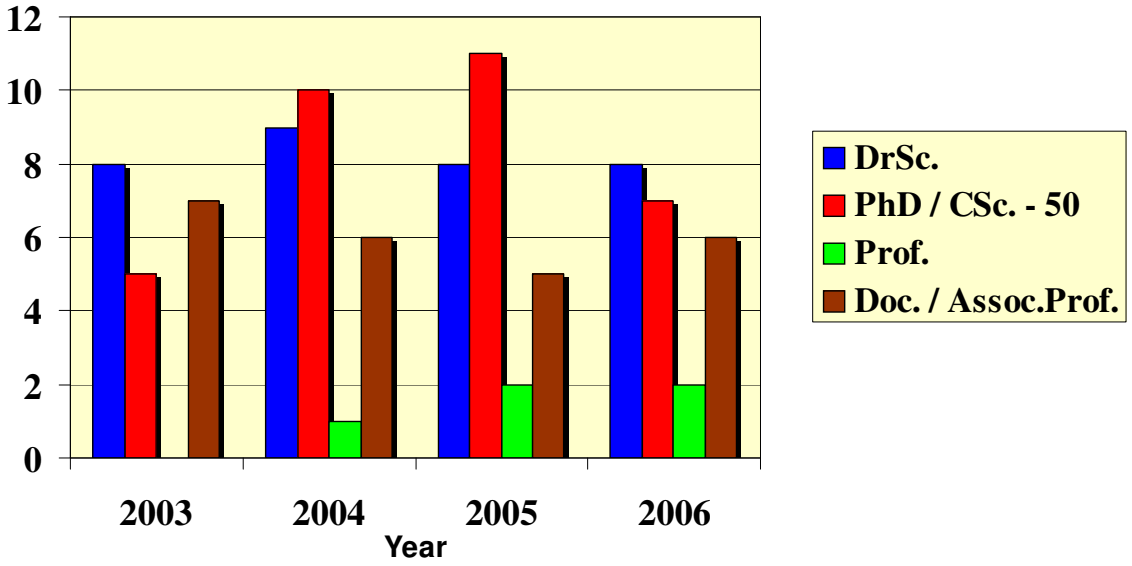
# University Degree Staff (FTE) in Departments of IEP SAS in 2006



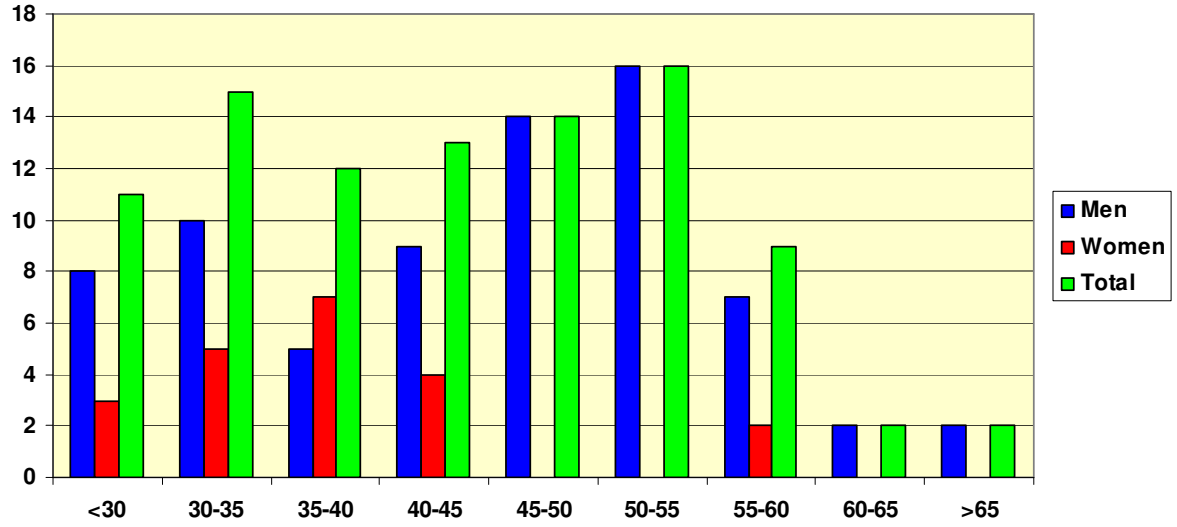
# Personnel



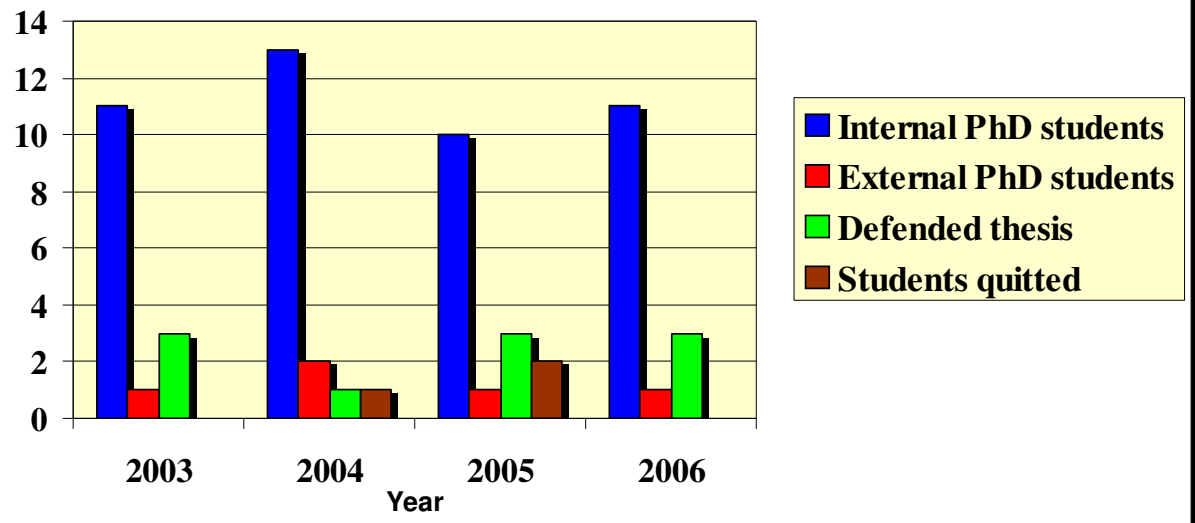

# Qualification Structure



## Age Distribution of Staff Participating in Scientific Projects in 2006




# PhD Study



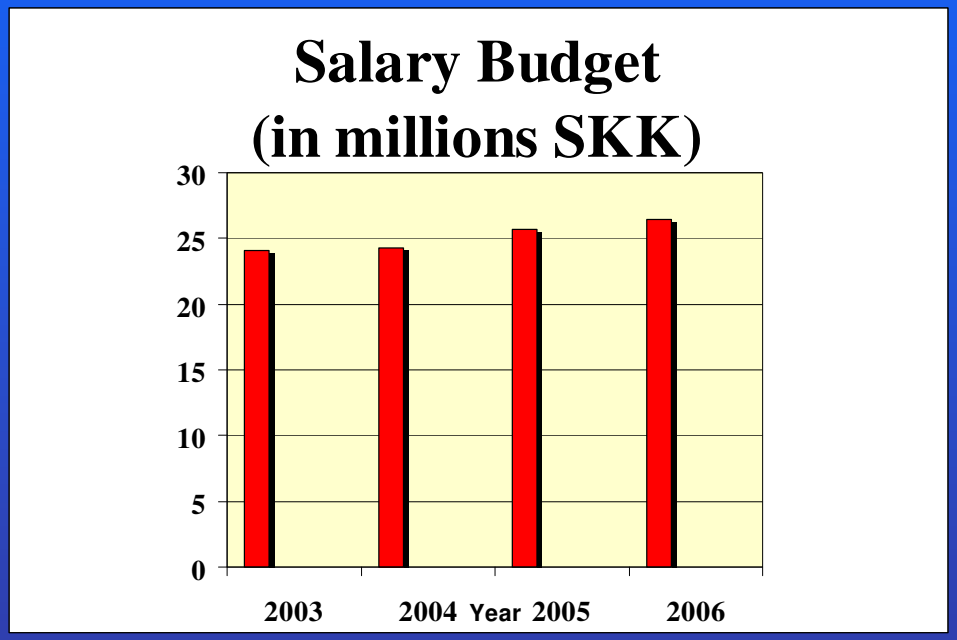
# Programmes of Doctoral Studies

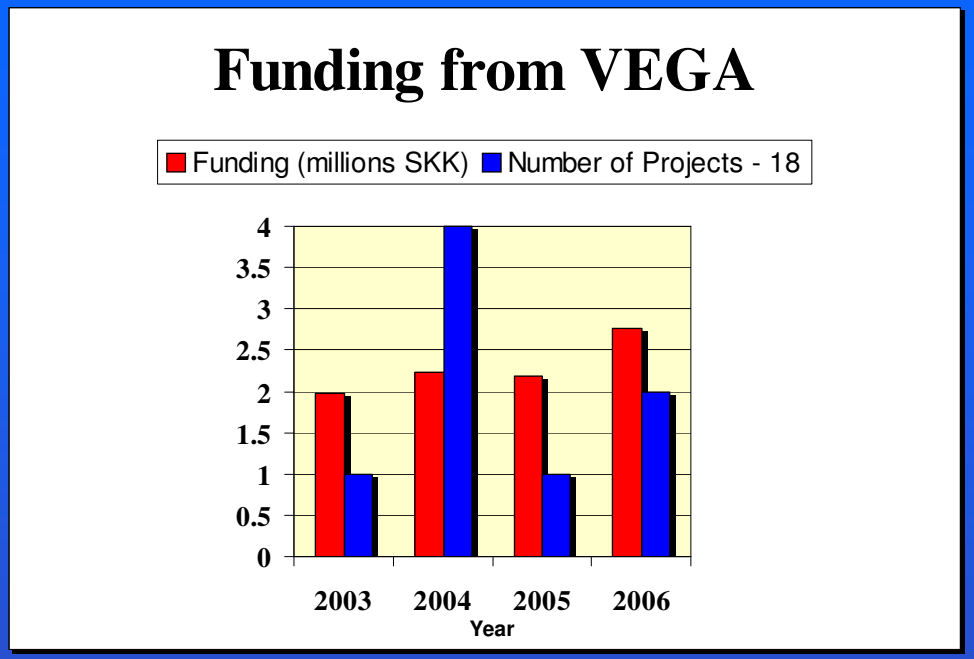
- In the previously effective legislation:
  - 11-22-9 Physics of condensed matter and acoustics
  - 11-24-9 Nuclear and subnuclear physics
- In the recently amended Act on the Universities:
  - 2.4.1 General physics and mathematical physics
  - 4.1.3 Physics of condensed matter and acoustics
  - 4.1.5 Nuclear and subnuclear physics
- Doctoral study is realized in close collaboration with Faculty of Natural Sciences UPJŠ Košice
- 7 postdocs in IEP SAS Košice supported by Stefan Schwarz science supporting fund

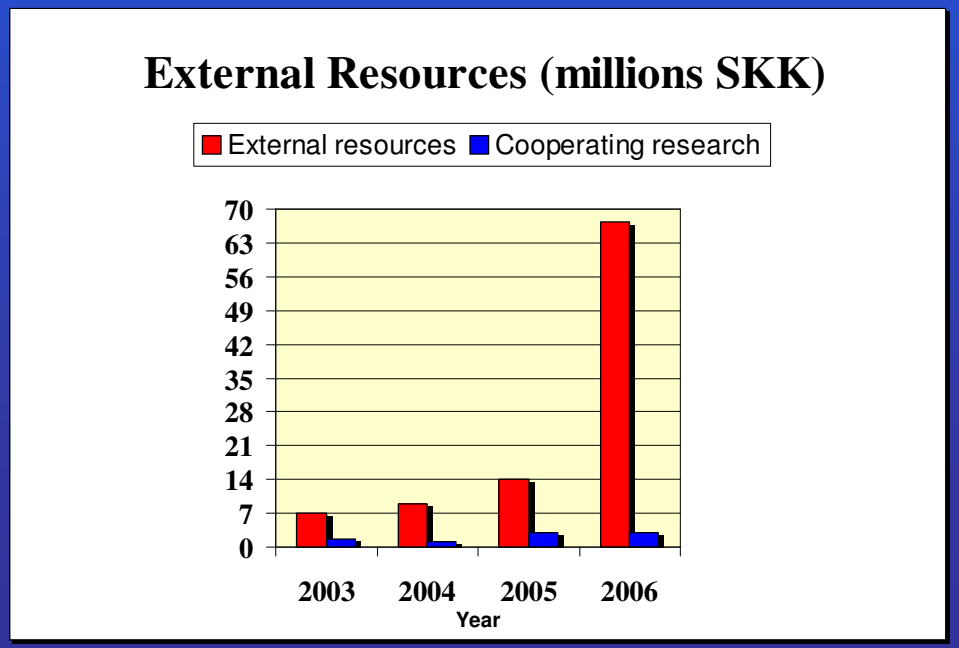
# Pedagogical Activites

| Teaching | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|
| lectures (hours/year) | 483 | 565 | 617 | 743 |
| practicum courses (hours/year) | 436 | 390 | 698 | 493 |
| supervised diploma works (in total) | 12 | 5 | 5 | 11 |
| members in PhD committees (in total) | 10 | 7 | 13 | 10 |
| members in DrSc. committees (in total) | 4 | 3 | 3 | 6 |
| members in university/faculty councils (in total) | 2 | 2 | 2 | 2 |
| members in habilitation/inauguration committees (in total) | 2 | 4 | 2 | 2 |

# Funding


Salary Budget
(in millions SKK)
30
25
20
15
10
5
0
2003
2004
Year
2005
2006


Funding from VEGA
Funding (millions SKK)
Number of Projects - 18
4
3.5
3
2.5
2
1.5
1
0.5
0
2003
2004
2005
2006
Year


External Resources (millions SKK)
External resources
Cooperating research
70
63
56
49
42
35
28
21
14
7
0
2003
2004
2005
2006
Year

# Total Research Outputs of IEP SAS Košice in Review Period 2003-2006

| | number | averaged number per year | av. No. / FTE | av. No. / salary budget |
|---|---|---|---|---|
| **Chapters in monographs, books published abroad** | 4 | 1.0 | 0.01 | 0.04 |
| **CC publications** | 433 | 108.3 | 1.43 | 4.31 |
| **Scientific publications indexed by other databases: WOS** | 21 | 5.3 | 0.07 | 0.21 |
| **Scientific publications indexed by other databases: SCOPUS** | 44 | 11.0 | 0.15 | 0.44 |

# List of 10 top-cited publications

1. **SZABÓ, P.** – **SAMUELY, P.** – **KAČMARČÍK, J.** – KLEIN, T. – MARCUS, J. – FRUCHART, D. – MIRAGLIA, S. – MARCENAT, C. – JANSEN, A.G.M. Evidence for Two Superconducting Energy Gaps in $MgB_2$ by Point-Contact Spectroscopy. In *Physical Review Letters* Vol. 87, no. 13 (2001), p. 137005-1-4. cond-mat/0105598. WOS: 215 citations.
2. H1 Collaboration (**ADLOFF, C.** – … – **BRUNCKO, D.** – … – **FERENCEI, J.** – … – **KURČA, T.** – … – **MURÍN, P.** – … ) Deep-inelastic inclusive ep scattering at low x and a determination of $\alpha_s$. Preprint DESY-00-181, Dec 2000, 68 pp. In *European Physical Journal C*. Vol. 21, no. 1 (2001) p.33-61. e-Print Archive: hep-ex/0012053. WOS: 127 citations.
3. H1 Collaboration (AKTAS, A. - … – **BRUNCKO, D.** – … – **FERENCEI, J.** – … – **MURÍN, P.** – …) Evidence for a Narrow Anti-Charmed Baryon State. Preprint DESY-04-038. In *Physics Letters B*. Vol.588, no.1-2 (2004), p. 17-28. hep-ex/0403017. WOS: 92 citations.
4. LYARD, L. – **SAMUELY, P.** – **SZABÓ, P.** – KLEIN, T. – MARCENAT, C. – PAULIUS, L. – KIM, K.H.P. – JUNG, C.U. – LEE, H.S. – KANG, B. – CHOI, S. – LEE, S.I. – MARCUS, J. – BLANCHARD, S. – JANSEN, A.G.M. – WELP, U. – KARAPETROV, G. – KWOK, W.K. Anisotropy of the upper critical field and critical current in single crystal $MgB_2$. cond-mat/0206231. In *Physical Review B. – Condensed Matter*, Vol. 66, no.18 (2002), p. R180502-1-4. WOS: 52 citations
5. KOPELIOVICH, B.Z. – **NEMCHIK, J.** – SCHAFFER, A. – TARASOV, A.V. Cronin effect in hadron production off nuclei. In *Physical Review Letters*. Vol.88, no.23 (2002) p. 232303-1-4. hep-ph/0201010. WOS: 45 citations.

# List of 10 top-cited publications

6. WA97 Collaboration (ANDERSEN, E. - ...- **BÁN, J.** - ... - **JUSKO, A.** - ... - **KRÁLIK, I.** - ... - **LUPTÁK, M.** - ... - **PASTIRČÁK, B.** - ... - **ŠAFAŘÍK, K.** - ... - **ŠÁNDOR, L.** - ... - **URBÁN, J.** - ...) Enhancement of central Lambda, Xi and Omega yields in Pb-Pb collisions at 158 AGeV/c. CERN-EP-98-064, CERN-EP-98-64, Apr. 1998, 9pp. In *Physics Letters B*. Vol.433, no.1-2 (1998) p.209-216. WOS: 36 citations.
7. WA97 Collaboration (ANDERSEN, E. - ...- **BÁN, J.** - ... - **JUSKO, A.** - ... - **KRÁLIK, I.** - ... - **LUPTÁK, M.** - ... - **PASTIRČÁK, B.** - ... - **ŠAFAŘÍK, K.** - ... - **ŠÁNDOR, L.** - ... - **URBÁN, J.** - ...) Strangeness enhancement at mid-rapidity in Pb-Pb collisions at 158 A GeV/c. In Physics Letters B. vol.499 (1999) p.401-406. CERN-EP-99-029, CERN-EP-99-29, Jan 1999, 9pp. WOS: 36 citations.
8. **KONERACKÁ, M.** – **KOPČANSKÝ, P.** – **ANTALÍK, M.** – **TIMKO, M.** – RAMCHAND, C.N. – LOBO, D. – MEHTA, R.V. – UPADHYAY, R.V. Immobilization of proteins and enzymes to fine magnetic particles. In *Journal of Magnetism and Magnetic Materials*. Vol.201, no.1-3. (1999) p.427-430. WOS: 31 citations.
9. **DIKO, P.** Growth-related Microstructure of Melt-Grown $REBa_2Cu_3O_y$ Bulk Superconductors. Invited talk at Superconducting Materials Research and Technology conference, Giens Peninsula – Heyres, France, September 19 – 23, 1999. In *Superconductors Science Technology*. Vol.13, no.8 (2000) p.1202-1213. WOS: 29 citations.
10. **SEDLÁK, M.** – Amis, E.J. Dynamics of moderately concentrated salt-free polyelectrolyte solutions: molecular weight dependence. In *Journal of Chemical Physics*. Vol.96, no.1 (1992) p.817-825. WOS: 21 citations.

# Total Citations of IEP SAS Košice in Review Period 2003-2006

| | number | averaged number per year | av. No. / FTE | av. No. / salary budget |
|---|---|---|---|---|
| Web of Science | 3694 | 923.5 | 12.2 | 36.7 |
| SCOPUS | 159 | 39.8 | 0.5 | 1.6 |
| SLAC SPIRES | 767 | 191.8 | 2.5 | 7.6 |
| NASA ASTROPHYSICS | 17 | 4.3 | 0.1 | 0.2 |
| In monographs, conf. proc. and other publications abroad | 87 | 21.8 | 0.3 | 0.9 |

# International Scientific Projects

- 18 international projects within the European Research Area in total in review period
- for 2 international projects: "6FP EU MTKD-CT-2005-030002 ExtreM" and "INTAS 03-51-3036" IEP SAS Košice is coordinating Institute

# International Institute Agreements

- Institute of Molecular Physics Polish Academy of Sciences, Poznaň, 2007 – 2009
- Institute for Low Temperature Physics and Engineering of National Academy of Sciences of Ukraine, Kharkov, 2006 – 2010
- Institute of Nuclear Physics Polish Academy of Sciences, Krakow, 2005 – 2007
- Centre for Fundamental and Advanced Technical Research of Romanian Academy, Timisoara, 2004 – 2007
- Research Institute for Solid State Physics and Optics, Hungarian Academy of Sciences, Budapest, 2004 – 2007
- Institute for Low Temperature Physics and Engineering of National Academy of Sciences of Ukraine, Kharkov, 2004 – 2007
- Matematicko-fyzikálna fakulta, Univerzity Karlovej, Praha, 2001 – 2006
- Department of Physics Lancaster University, United Kingdom, 2005 – 2007
- Institut obščej fyziky RAS, Moskva, to the end of 2007
- Institut  for Problems of Materials Science NAS Ukraine, 2004 – 2008
- Institut for Metal Physics of NAS of Ukraine, 2005 – 2007
- The Material Science Center, Department of Applied Physics, University of Groningen, Netherlands, 2006 – 2008

# International Institute Agreements

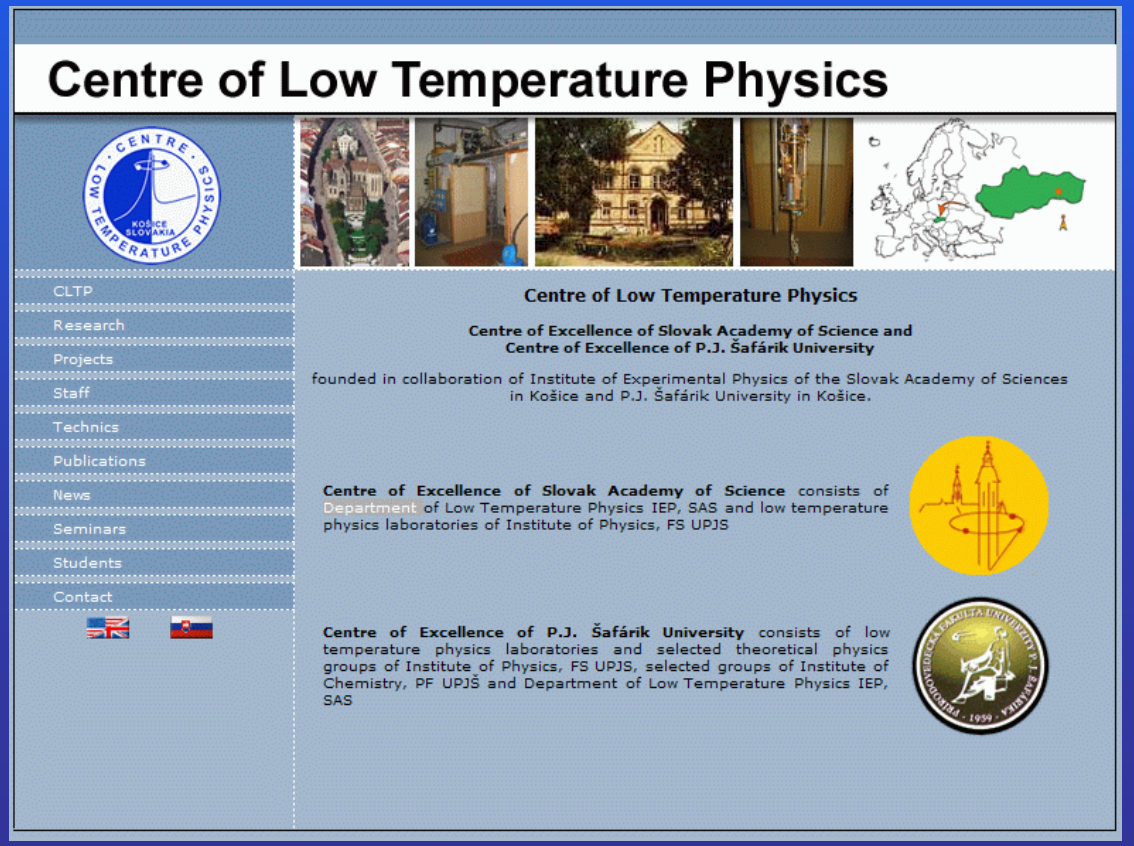
- Max-Planck-Institut fur Physik Werner-Heisenberg Institut Munchen, Germany
- Central Research Institute of Physics RMKI, Budapest
- Main Astronomical Observatory National Academy of Sciences of Ukraine, 2005 – 2009
- Objedinenyj institut jadernych isledovanij, Dubna, 2005 – 2008
- Uzhorod national university, Ukraine, 2005 – 2009
- Institute for Condensed Matter Physics NAS, Ukraine, 2003 – 2007
- Institute of Physics St. Petersburg University, Russia, 2001 – 2006
- Space Research Institute, RAS, Moscow, Russia, 2005 – 2008
- Space Research Laboratory, Demokritus University of Thrace, Xanthi, Greece, 2005 – 2008
- Ústav jadrovej fyziky AV ČR, Praha, 2006 – 2010
- IZMIRAN, Russian Academy of Sciences, Troitsk, Russia, 2004 – 2007
- Lebedev Physical Institute of Russian Academy of Sciences, Moscow, Russia, 2006 – 2010
- Ústav organickej chémie a biochémie AV ČR, Praha, 2002 – 2006
- Biofyzikální ústav AV ČR, Brno, 2002 - 2006

# Centre of Excellence

## CFNT CE-I/2/2003 Centre of Low Temperature Physics IEP SAS and P.J.Šafárik University

Coordinator: P.Samuely

http://ofnt.saske.sk/



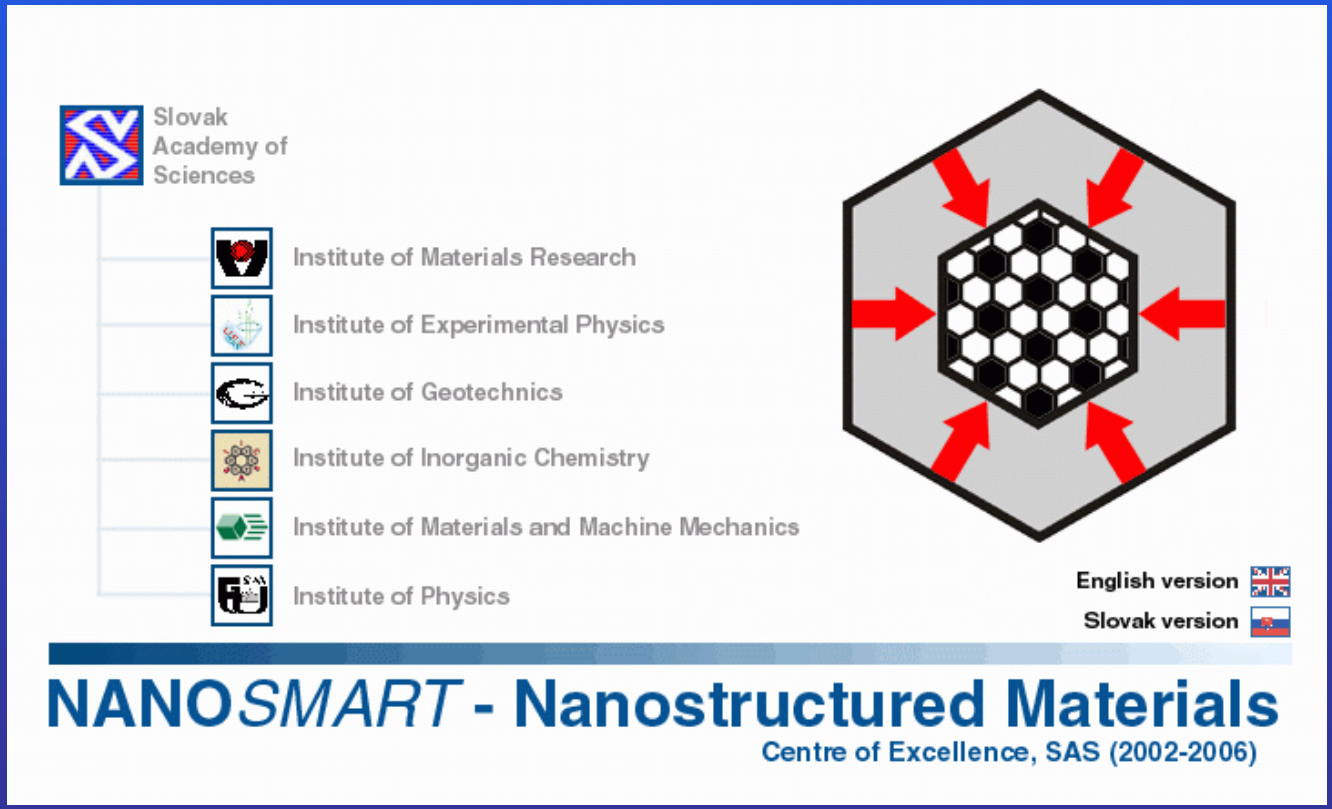
# Centre of Excellence

## NANOSMART: NANOSM-1, NANOSM-2

SAS Institutes: IMR, IEP, IG, IICH, IMMM, IP

IEP SAS Coordinators: P. Diko, I. Škorvánek

http://www.imr.saske.sk/umv/NANOSMART/index.htm



# Conferences

- 19 international conferences **hosted** by IEP SAS Košice during evaluation period with the largest ones being DIS 2004 (with 257 registered participants) and CSMAG 2004 (>200).
- 3 large international conferences **in preparation**: SQM 2007 (120), CSMAG 2007 (>200), ICMF 11 (321 )

DIS 2004

SQM 2007

11th International Conference on Magnetic Fluids

CS

IEP SAS Košice dedicated to the basic research in these fields of physics:

Space physics
Subnuclear physics
Physics of the condensed matter
Biophysics

Subject of study: physical properties of matter and processes taking place

- in the **temperature** range from almost the lowest experimentally accessible values close to 0 K (liquid helium) up to $10^{12}$ K (the "melting" temperature of protons and neutrons) and

- at **distances** lower than $10^{-15}$ m (size of the proton) up to the interplanetary ones (millions of kilometres)

# Temperature scale: 273,15 Kelvin = 0°C

Temperature [ Kelvin ]

$10^{9}$
$10^{8}$
$10^{7}$
$10^{6}$
$10^{5}$
$10^{4}$
$10^{3}$
$10^{2}$
$10^{1}$
$10^{0}$
$10^{-1}$
$10^{-2}$
$10^{-3}$
$10^{-4}$
$10^{-5}$
$10^{-6}$

← Cores of hot stars

← Solar core, nuclear energy

← Chemical energy

← Melting point of Tungsten

← Temperature suitable for life

← Cosmic relict radiation temperature, 2,7K – the lowest temperature in nature

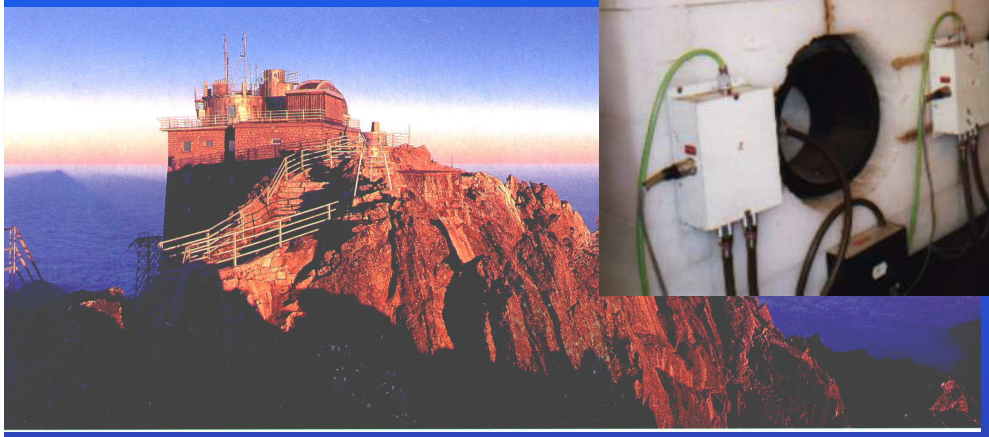
← Superfluid 3He

← 50 μK - the lowest temperature reached in IEP SAS Košice

← 4 μK - the lowest temperature reached in the laboratory

# Department of Space Physics

- long term measurements of the cosmic radiation at Lomnický Štít
- several experiments in space

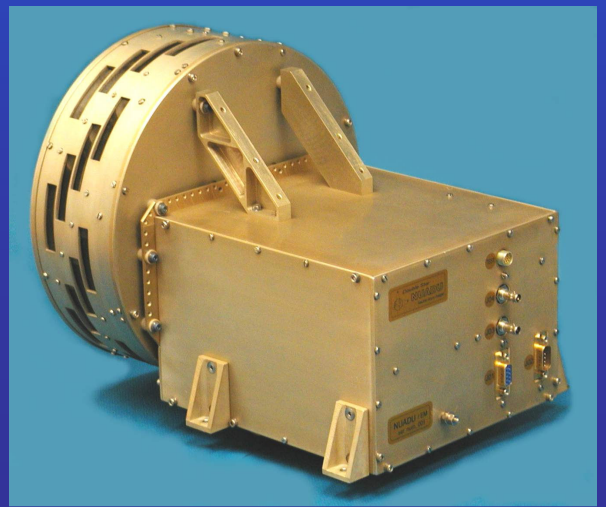


**Subject of interest:**

Particles not in the thermal equilibrium with the plasma environment in space

- ground based measurements (indirect, secondary particles in the atmosphere)
- satellite measurements (lower energies, Earth magnetosphere)

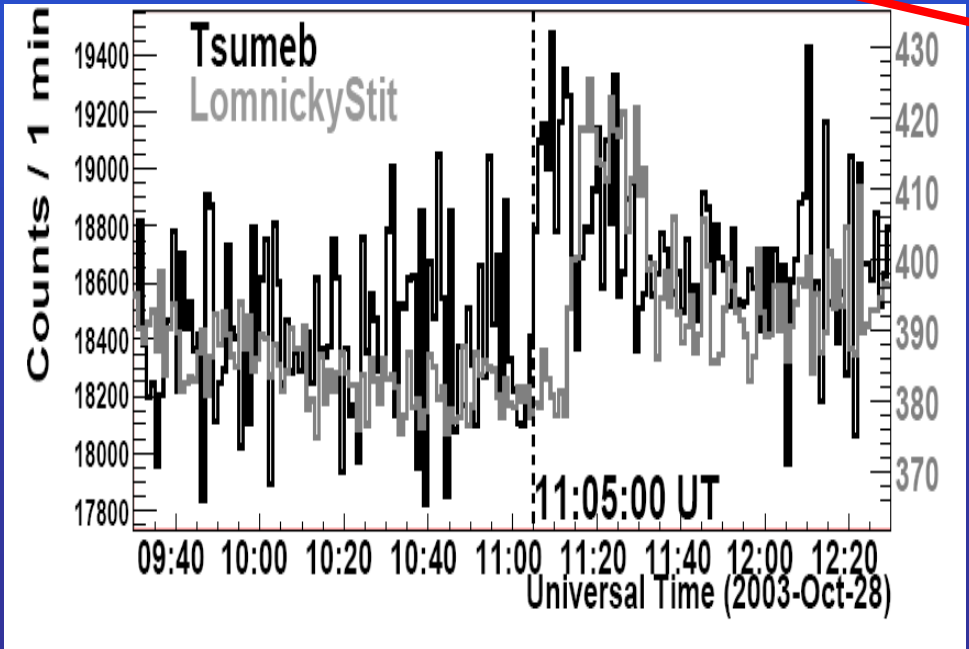
The latest experiment developed with participation of Dept. of Space Physics is the instrument **NUADU on board TC-2 satellite of Double Star mission** (Collaboration ESA - China, launched on 25.7.2004). Remote sensing of energetic neutral atoms near Earth.

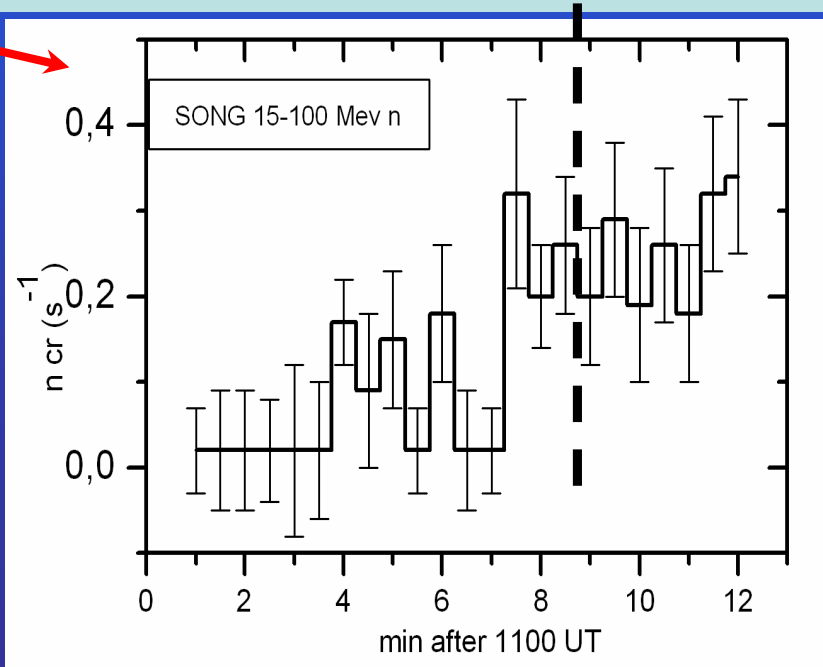


# Department of Space Physics
## - selected results

Long term study of solar neutron and gamma ray emission problem (observations, data analysis) started ***25 years ago (flare June 3, 1982) - first response of neutrons from solar flares on the ground observed*** (***at Jungfraujoch, and at Lomnický Štít***).

Strong emission of high energy gamma rays and indication of neutrons was obtained by CORONAS-F (SONG instrument, joint of SINP Moscow U., and of DSP). Explanation of difference in onset time for Tsumeb and Lomnický Štít is supported by CORONAS measurements of neutrons 15 – 100 MeV during solar extreme event Oct. 28, 2003



# Department of Space Physics
## - selected results 2

Extensive data set (4 years of measurements in the region upstream from the Earth's bow shock on ***Interball-1*** (***experiment DOK-2, joint of IEP SAS; DUT Xanthi, Greece; SRI RAS Moscow***) identified two mechanisms contributing to upstream ion population: shock acceleration by Fermi (SW); leakage from magnetosphere.

Relative importance of the two mechanisms illustrated by correlations of 2min flux with $Q_{Bn}$ (angle between ***B*** and nomal to the bow shock at intersection point); with distance to bow shock position and with geomagnetic activity on energy.

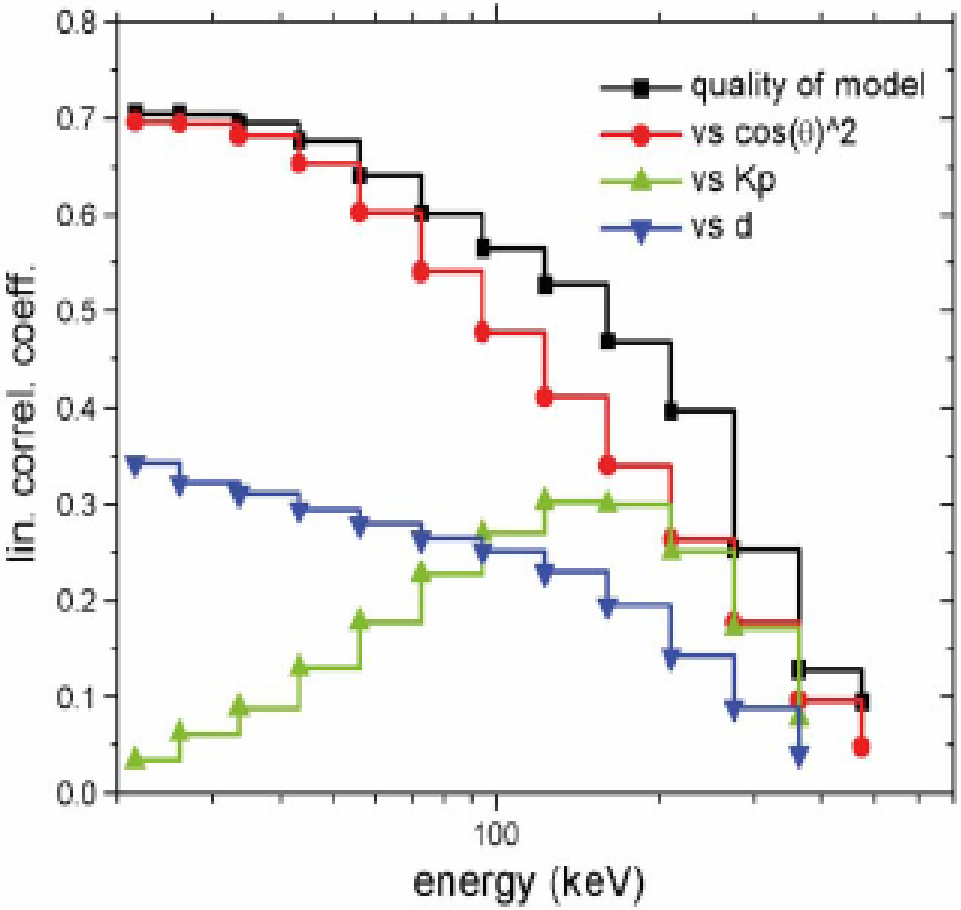



Fig. 5. Absolute values of correlation coefficients of log(1p) at different energies versus square of cosine of angle $\theta_{Bn}$, versus $K_p$ and versus $d$. At the lowest energies the model is $\log(1p1) = (-1.01 \pm 0.04) + (2.82 \pm 0.04)*\cos^2(\theta_{Bn}) - (0.015 \pm 0.002)*d + (0.0077 \pm 0.0009)*K_p$.

# Department of Space Physics
## - more selected results

Neutral Atom Imager (NUADU) on Double Star satellite, designed with significant input of the Department, is providing unique data since August 2001 on spatial distribution and temporal variability of energetic neutral atoms near the Earth.

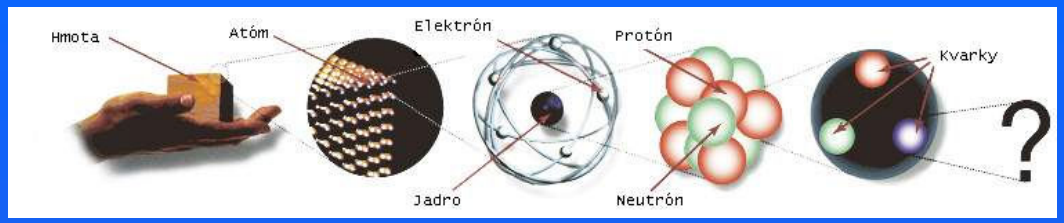
Variations of long term evolution of geomagnetic cut-off rigidity for various sites on Earth for period of years 0 – 2000 were estimated and transmissivity function for cosmic rays computed for a low altitude satellite.

Hard X ray flux above the atmosphere was detected in conjunction with strong atmospheric lightning indicating that electron precipitation was a driver for that effect. Relations of gamma ray flux observed on CORONAS-F to that of energetic electrons at low altitudes were found.

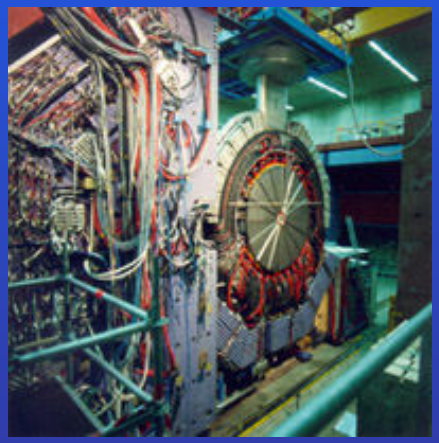
More info at http://space.saske.sk

# Department of Subnuclear Physics

**Main orientation:**
Basic research in the field
of the High Energy Physics
- Structure of the proton
- Collisions of heavy ions at high energies
- Search for new building blocks of matter
- Extremely high energetic cosmic rays



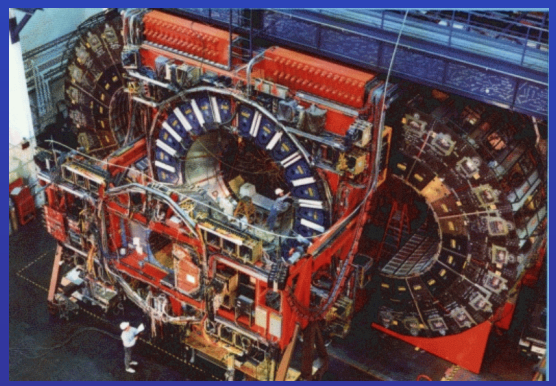

**International projects with our participation:**



## H1 in DESY Hamburg, Germany
- Study of the proton structure
- Search for new particles and interactions beyond the established theory of elementary particles


## NA57 at CERN Geneva, Switzerland
- Study of the high energy heavy ion collisions
- Search for a new state of matter: quark-gluon plasma

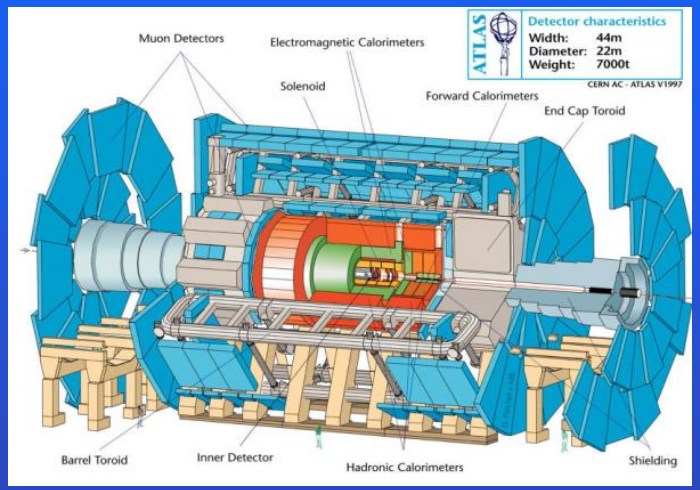
## CDF in Batavia, USA
- Participation in the top quark discovery
- Building of PC farms



# Department of Subnuclear Physics

## Our future: Large Hadron Collider in CERN

### ATLAS – A Toroidal LHC apparatus



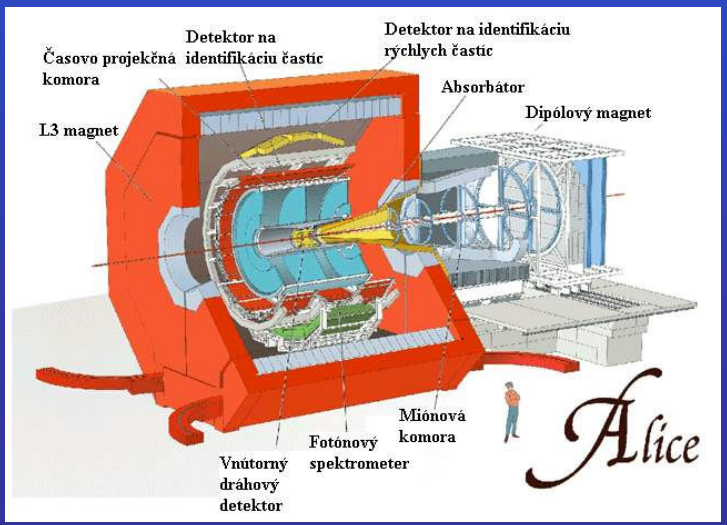

**Study of the pp collisions at the LHC energy**

- Tests of the existing theory of elementary particles
- Search for new building blocks of matter
- Search for "new physics" phenomena

### ALICE – A Large Ion Collider Experiment

**Study of the ultrarelativistic collisions of heavy nuclei at largest available energy**

Study of the new state of matter: quark-gluon plasma



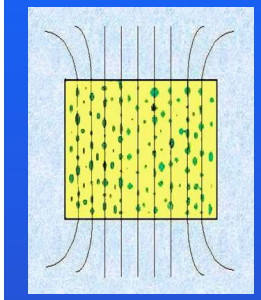
# Department of Subnuclear Physics

## Most important results in the review period:

- development, installation and tests of the on-line calibration system for hadronic end-cap calorimeters in ATLAS detector
- validation of GEANT 4 simulation tool, especially in hadronic processes
- determination of the top quark mass in dilepton channel in p anti-p collisions in CDF detector in Tevatron collider
- full analysis of strangeness enhancement in Pb-Pb collisions at 40 and 160 A GeV/c in NA57 experiment in CERN
- analysis of the proton structure functions $F_2$ and $F_L$ (longitudinal) in electron proton collisions in H1 detector at HERA collider

# Department of Magnetism

## High-temperature superconductors



Magnetic field may be 15 times higher than the field of traditional permanent magnets
$B_{max}$: 1.5 T at 77 K,
17 T at 30 K.

Unique property: stable levitation in magnetic field.

## Possible practical applications

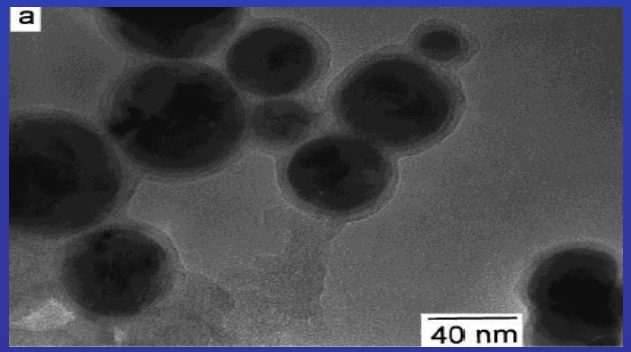
**MAGLEV** magnetic levitating train for speeds over 500 kph

**Contactless transporter** for superclean environments

**Magnetic separator.** Superconducting permanent magnet can be used for cleaning of water

## Nanocrystalline materials

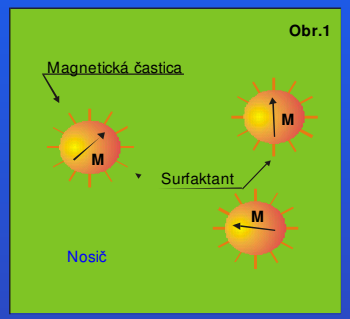
Nanostructural materials containing ultrafine super-paramagnetic particles based on Gd a Dy exhibit promising magnetocaloric properties which makes them suitable **as media for magnetic cooling at cryogenic temperatures**



# Department of Magnetism

## Magnetic liquids

- Magnetic material: Fe3O4 , Co, Fe,
- Carrier liquid: water, oil, kerosene,
- Surfactant: oleic acid, sodium oleate, detergents ...
- Diameter of particles: 4 – 20 nm




## Basic properties:

Magnetic fluid remains fluid in any magnetic field

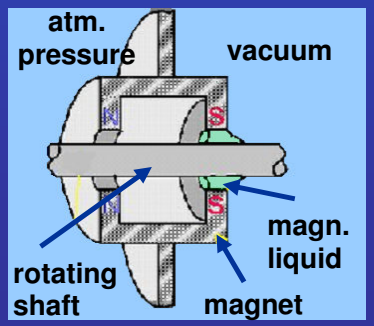
MF has properties magnetic as well as fluid, which opens possibilities of technical and biomedical applications.

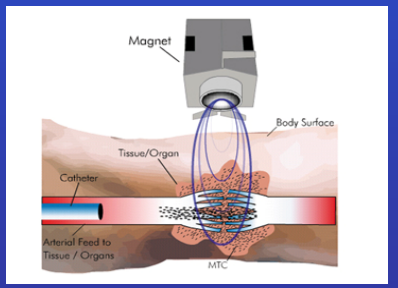
The properties of magnetic fluids can be changed by external magnetic fields.

## Applications of magnetic fluids in medicine:

- preparation of the mag. fluid-drug complex
- insertion into the blood system using magnetic field gradient
- release of drugs using enzyme activity, change of the physiologic conditions, pH or temperature

## Practical application:



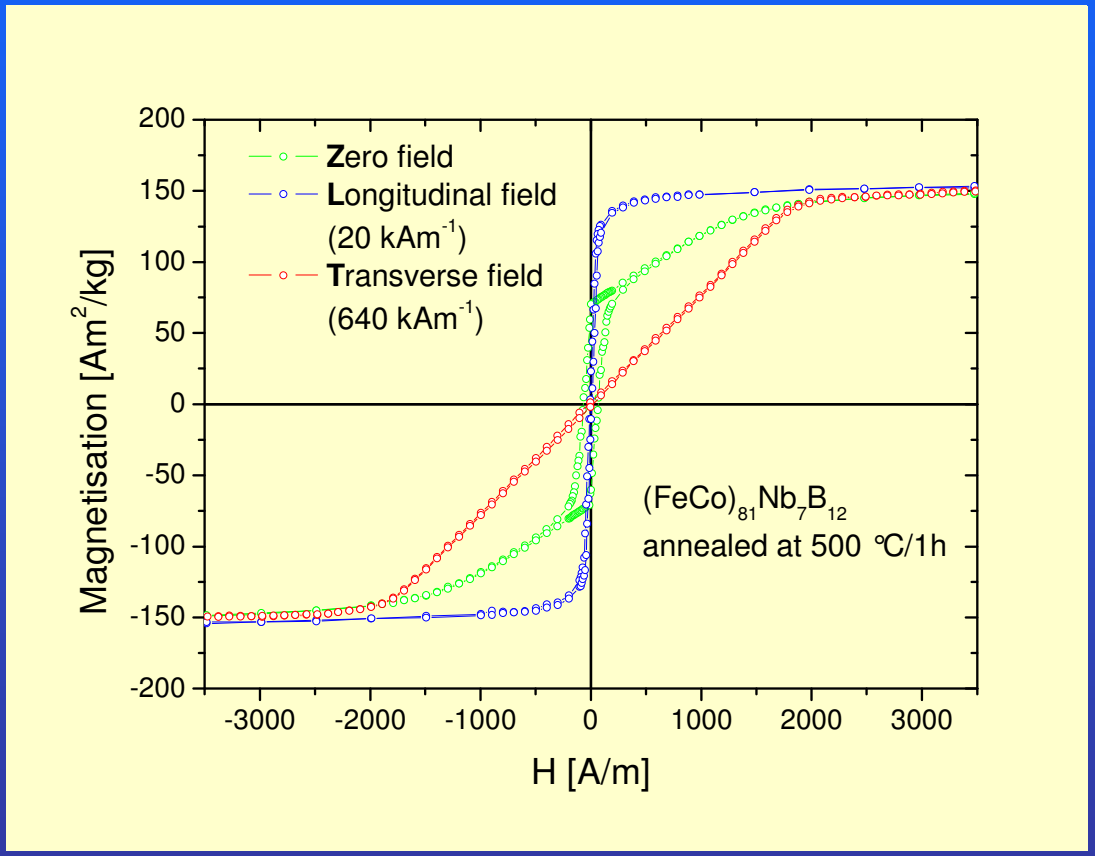




Sealing of rotating shafts

# Department of Magnetism

## Group of Nanostructured Magnetic Materials:

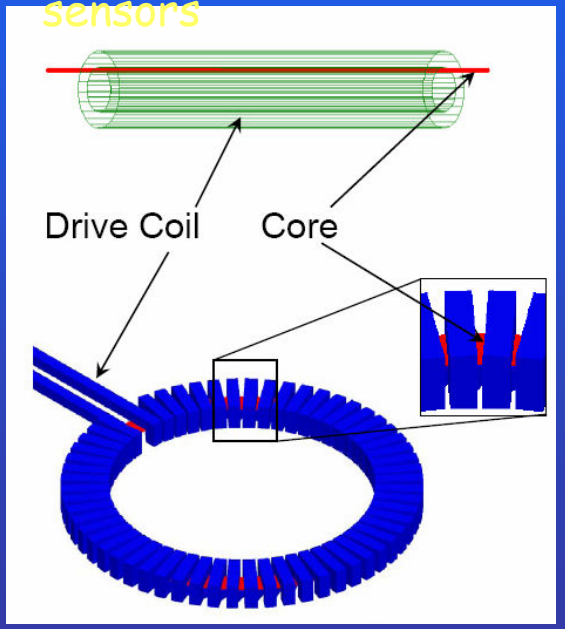
- **nanocrystalline soft magnetic materials** with Fe, FeNi and FeCo grains embedded in a residual amorphous matrix




Possibility to tailor the soft magnetic properties of nanocrystalline FeCo-based alloys by heat treatment in external magnetic field

Related papers: Appl. Phys. Lett. **85** (2004) 2884, **85** (2004) 1392, J.Magn. Magn. Mat. **304** (2006) 203, **310** (2007) 2494

Prospective magnetic materials for active core parts of various high performance sensors

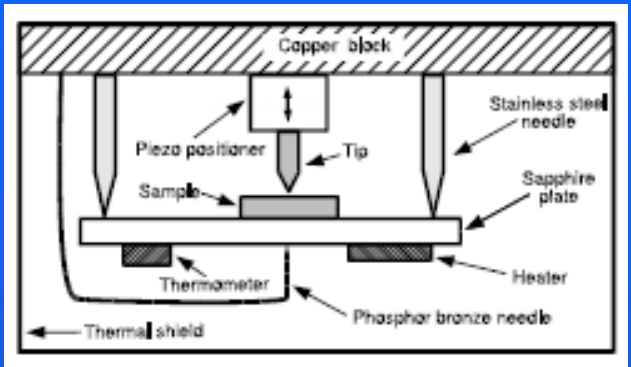



Variable Inductance

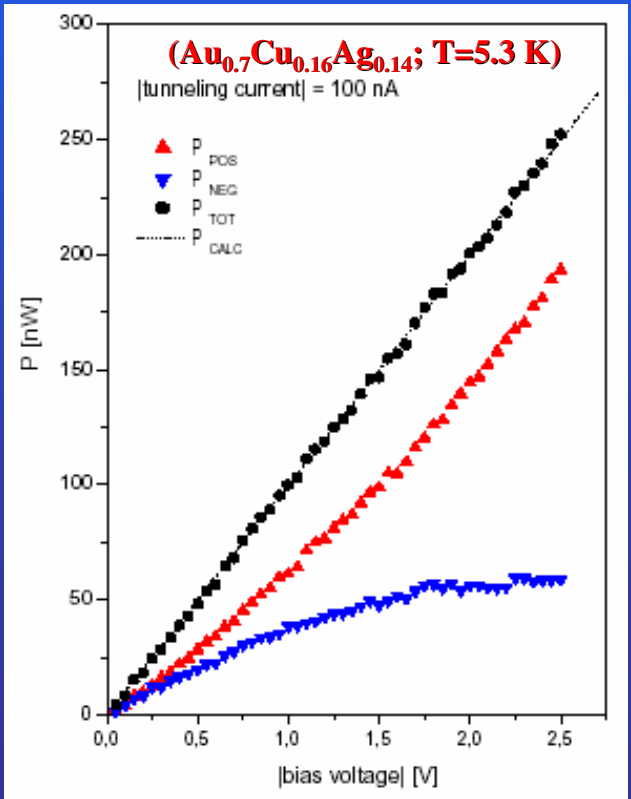
- Function of Drive Current
- Function of External Magnetic Field

# Department of Magnetism

Experimental setup :




Experimental results :




## Calorimetric tunneling experiments

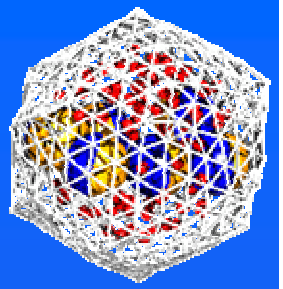
- Original (world first) experiment: the first exact calorimetric verification of the heating model for tunnel junctions (TJs)

-Observed asymmetrical power dissipation in individual TJ electrodes: the flow of tunneling current results in thermal gradients.
PERSPECTIVE APPLICATIONS: Novel studies of thermoelectric phenonena in tunnel structures - basic & applied research.

-Andreev reflection, detection of light emission in TJs, electronic refrigeration
- R & D of materials for micro- and nano-electronics: elimination of thermal gradients and power dissipation in TJs, improvements of electronic devices (especially unipolar)

I. Bat'ko, M. Bat'ková, Eur. Phys. J. Appl.Phys. 31 (2005) 191

# Department of Magnetism



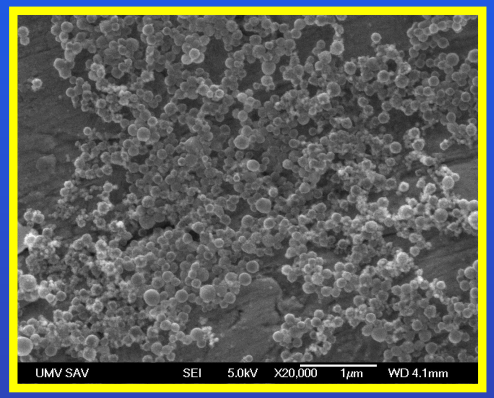
## ENCAPSULATION OF DRUG IN MAGNETIC BIODEGRADABLE POLYMER NANOPARTICLES

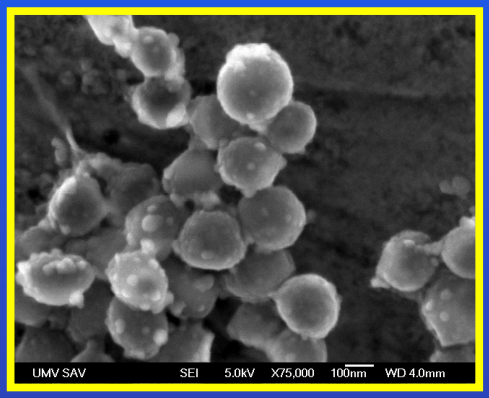
**Motivation:** preparation of drug loaded magnetic biodegradable polymer nanoparticles (Nps) by nanoprecipitation method for targeted drug delivery

***Preparation***

Rotoevaporator for preparing PLGA Nps

***Characterization***




SEM pictures of magnetic PLGA nanoparticles with anticancer drug Taxol

***Results***

magnetic response


M.Koneracká, P.Kopčanský, M.Timko, C.N.Ramchand, Z.M.Sayied, M.Trevan, A.de Sequeira: Immobilization of Enzumes on magnetic particles
Book: Immobilization of Enzymes and Cells, 2.edition, Edited by Jose M.Guisan in Humana Press-Totowa, New Jersey, 2006, p.217

V.Závišová, M.Koneracká, N.Tomašovičová, P.Kopčanský, M.Timko: Some immobilization modes of biologically active substances to fine magnetic particles. Z.Phys. Chem 220 (2006) 241-250

M.Timko, M.Koneracká, N.Tomašovičová, P.Kopčanský, V.Závišová: Magnetite polymer nanospheres loaded by Indomethacine for anti-inflammatory therapy. Journal of Magnetism and Magnetic Material 300 (2006) 191-194

# Department of Low Temperature Physics


## Ultra-low temperatures: < $10^{-3}$ K

The Centre of Very Low Temperature Physics belongs to a few laboratories in the world capable of working at ultra-low temperatures

## Physics at low temperatures:

- "ground state" of condensed matter
- macroscopic quantum phenomena

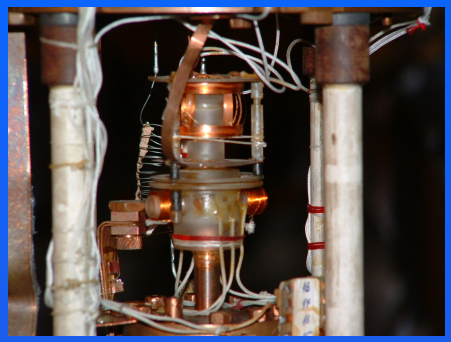
**superconductivity**- electric current without resistance

**superfluidity** - transport of matter without friction

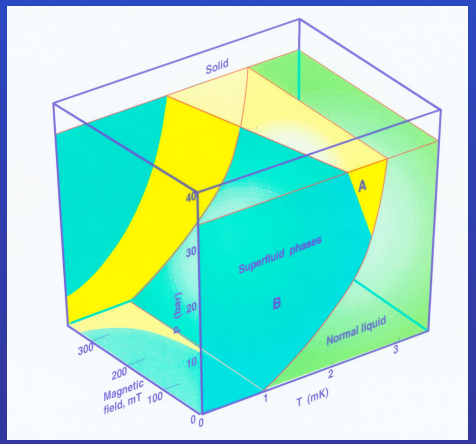
Helium liquefier, several cryostats and refrigerators covering temperatures from 200 μK up to room temperature

**Measurement techniques:** electric and thermal conductivity, specific heat, NMR, magnetisation and magnetic susceptibility, microcontact spectroscopy

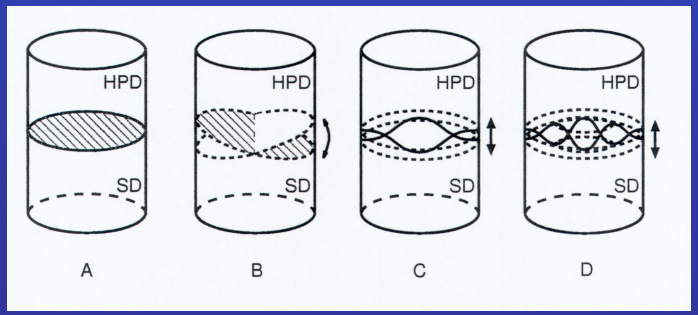
# Department of Low Temperature Physics



**Unique nuclear adiabatic demagnetization apparatus**
allows to study superfluid helium-3, the most complex condensed substance, model system for the cosmology.




Phase diagram of helium-3




Study of spin waves in helium-3

# HELIUM LIQUEFIER

## MODEL 1410

**start: 09.06.2006, 11:09 hr.**

**iquid helium: 10.06.2006, 15:28 hr.**

**Brief HISTORY**

1969 - first helium liquefier ZH4 manufactured by the Czechoslovak (now Czech) company Ferox Dečín put into operation, the nominal liquefaction rate - 4 litres of liquid helium per hour.

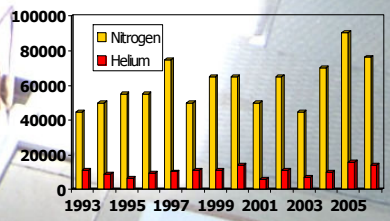
January 14, 1979, model 1400 liquefier manufactured by the CTi-Cryogenics was put into operation. LHe production rate was 10 litres per hour with LN2 precooling, 250 l storage dewar vessel.

1987 second compressor bought, the nominal liquefaction rate increased to 22 l LHe per hour, later the 250 l helium liquefaction dewar was replaced by a 1000 l one.

**Brief actual STATUS**

June 15, 2006 – fully automatic Helium Liquefier system model 1410 manufactured by the Cryogenic Plants and Services (CPS), USA, put into operation. The Model 1410 Helium Liquefier System is of modular design consisting of a liguefier module (Cold Box,Variable Speed Crosshead Drive, Instrument Control Panel, Safeties and Alarms, Delivery Tube and 1000 l storage dewar vessel) and Helium Compressor Model RSX. LHproduction rate is 35 litres per hour with

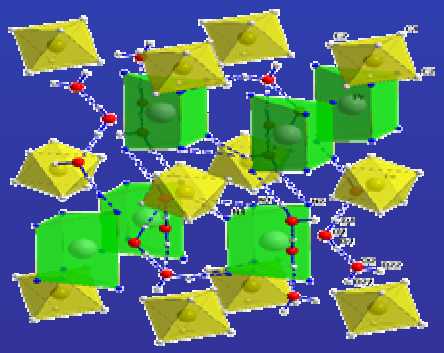
nitrogen (LN2) precooling.

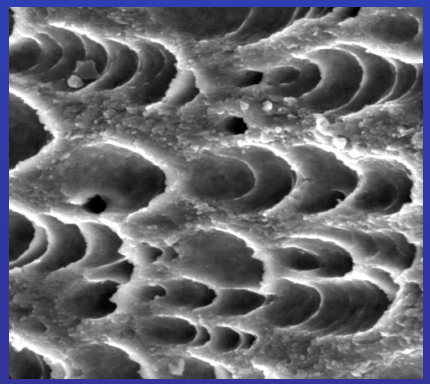


# Department of Metal Physics

## Basic research:

- **Study of mechanical properties,** plastic homogeneous and inhomogeneous deformation and creep of **amorphous and nanocrystalline metals** in a wide temperature range
- **Study of correlations between the structure and physical properties of substances**





- **New information** on laws governing deformations and creep in new types of materials
- **New materials with unique combinations of properties** (mechanical, magnetic ... )

## Methods of analysis:

- Thermic analysis (DSC, DTA, TG, TMA)
- Structural X-ray diffractography, microscopy, fractographic analysis
- Metallography

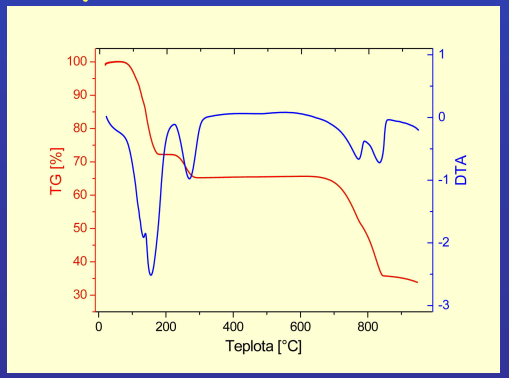
# Department of Metal Physics

## Preparation of materials:

- by the induction melting
- by the fast cooling of melted metal on rotating copper cylinder

## Study of thermal effects, changes of dimension and mass in a wide temperature range (20 – 1550 °C)

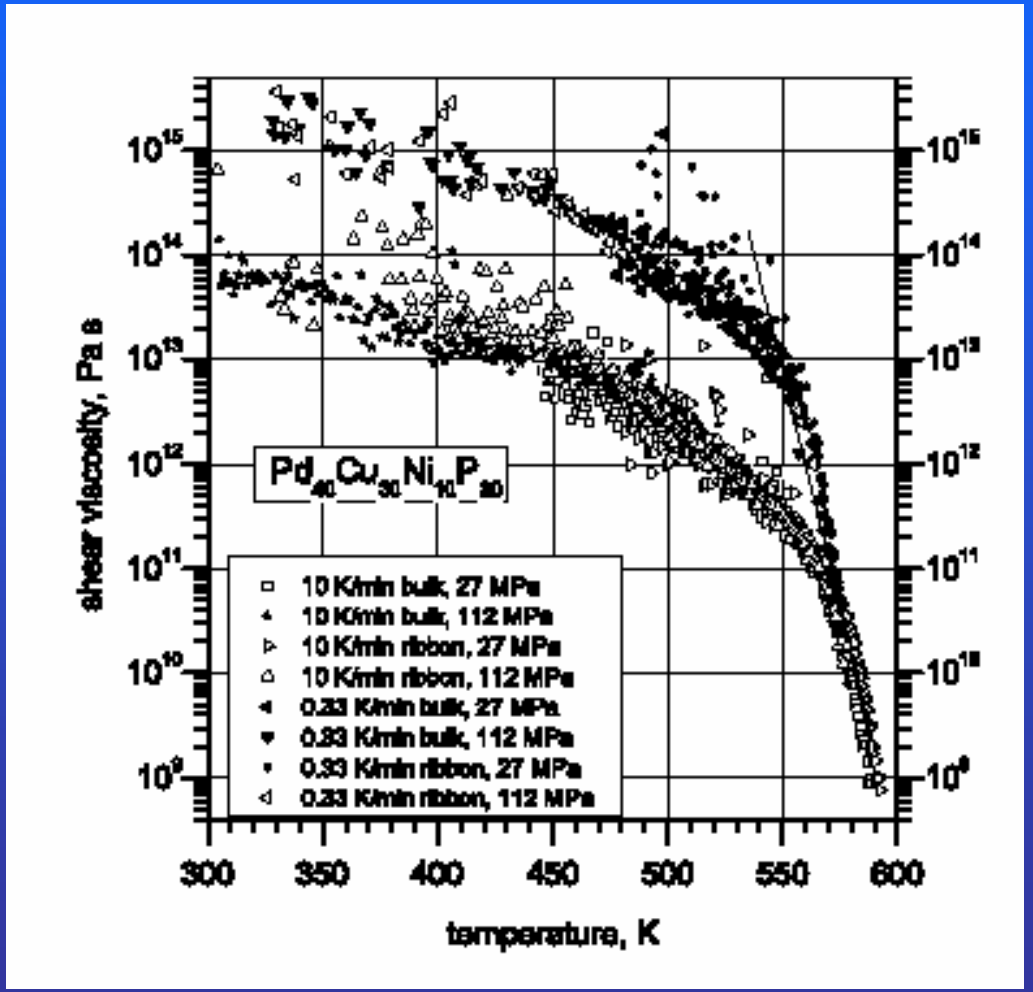
- **Setaram TGDTA 92** (differential thermal and thermogravimetric analysis)
- **Setaram TMA 9** (thermomechanical analysis)
- **Perkin Elmer DSC7** (differential scanning calorimetry)



# Department of Metal Physics

Homogeneous deformation of metallic glasses

Increasing of cooling rate of melt $Pd_{40}Cu_{30}Ni_{10}P_{20}$ (from $10^2$ to $10^6$ K/s) does not influence the shear viscosity in solid state



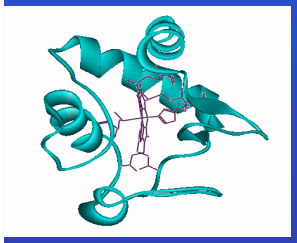
# Department of Biophysics

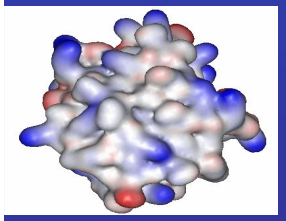
Study of relationships between the structure and the stability of biological macromolecules

**Methods of study:**
spectroscopic, calorimetric and hydrodynamic methods

**Biomacromolecules:**

Polymers with specific spatial arrangement of atoms





**Motivation for the study of the stability of macromolecules**

- the search of the relationship between structure and stability
- medical applications
- biotechnology

**Realization of various processes**

Information storage
Catalysis
Building of living organisms
Defence
Movement
Food

# Department of Biophysics

## Investigation of electrostatic interactions in microworld

**Experimental research of general physical properties of chemical systems in the presence of electric charges (mostly in synthetic ion polymers)**

Analytic and preparatory methods:

- static laser scattering
- dynamic laser scattering
- conductometry
- membrane osmometry
- vapour pressure osmometry
- lyofillisation
- high-speed centrifugation

## Applications of the research

Development of methods for ion materials testing

Baby diapers works "miraculously" thanks to superabsorbents – gels of ion polymers

**Intelligent materials**
drug carriers, superabsorbents

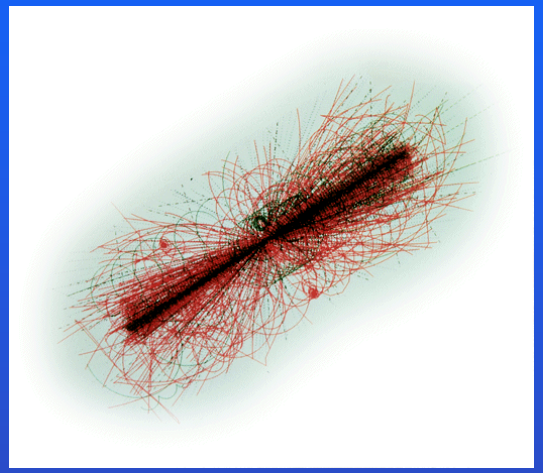
**Ecologic materials**
Water based building chemistry, water based paints, biodegradable polymers

# Department of Theoretical Physics

## Scientific activities:

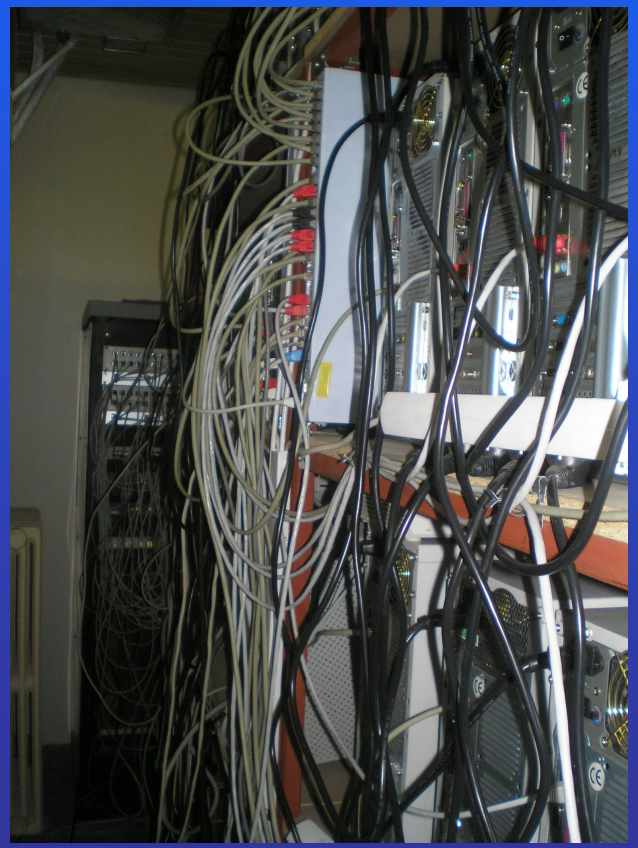
- Phenomenology of elementary particles
- Study of heavy fermionic systems in the condensed matter
- Study of nonlinear stochastic dynamics including the developed hydrodynamic and plasmatic turbulence
- Study of transport phenomena in biophysics
- The kinetics of particles in the cosmic space
- Study of systems containing the magnetic nanoparticles

Simulation of proton-proton collisions



# Computing Group

- services for all SAS institutes in Košice
- building GRID infrastructure



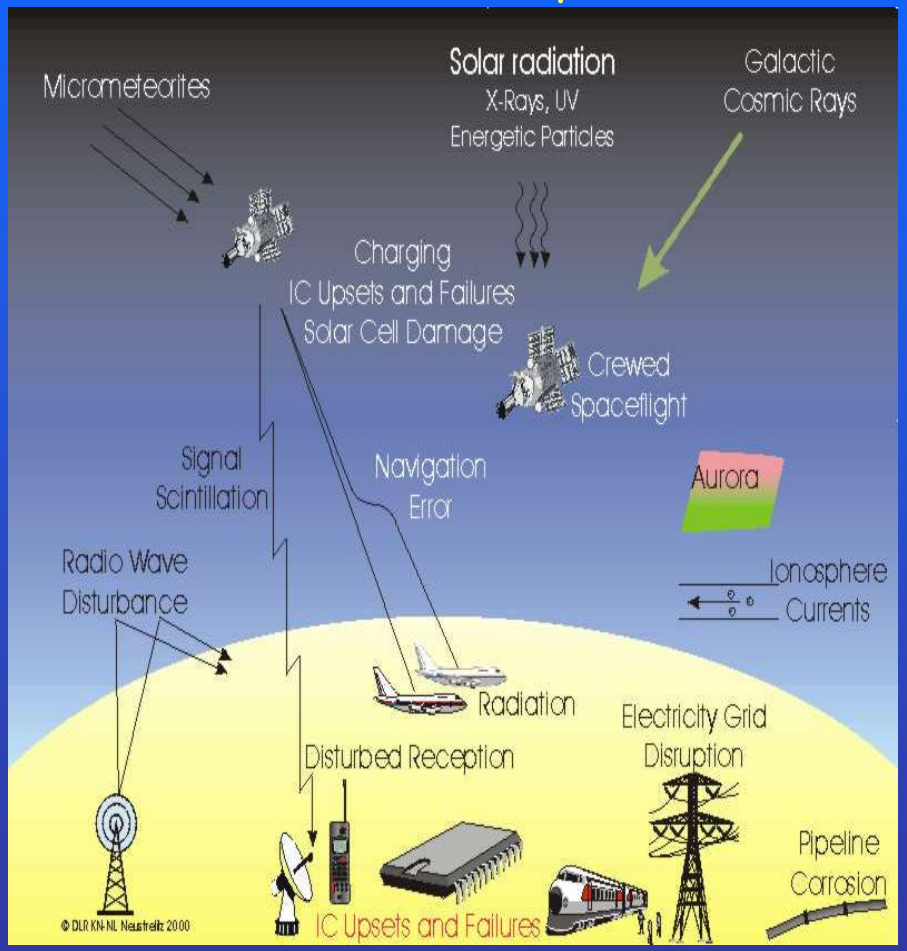
# Backup Slides

# Suggested projects for structural funds

- **Centre of progressive materials:** completion of the facilities (infrastructure) for investigations at low temperatures (STM, pressure, ac-calorimetry, calorimetric tunneling, PPMS, SQUID, etc.).
  - Laboratory of new materials technology
  - Laboratory of nano-structural materials
  - Laboratory of high-temperature superconductors (new pinning centers)
  - Laboratory of polymer and colloid – based materials
- Centre for space investigation and related applications
- Laboratory for detection of slow neutrons (Kolonické Sedlo)
- Centre of development, testing and application of elementary particle detectors
- Computer centre based on grid technology
- Centre of structural and functional analysis of biosystems

# Department of Space Physics

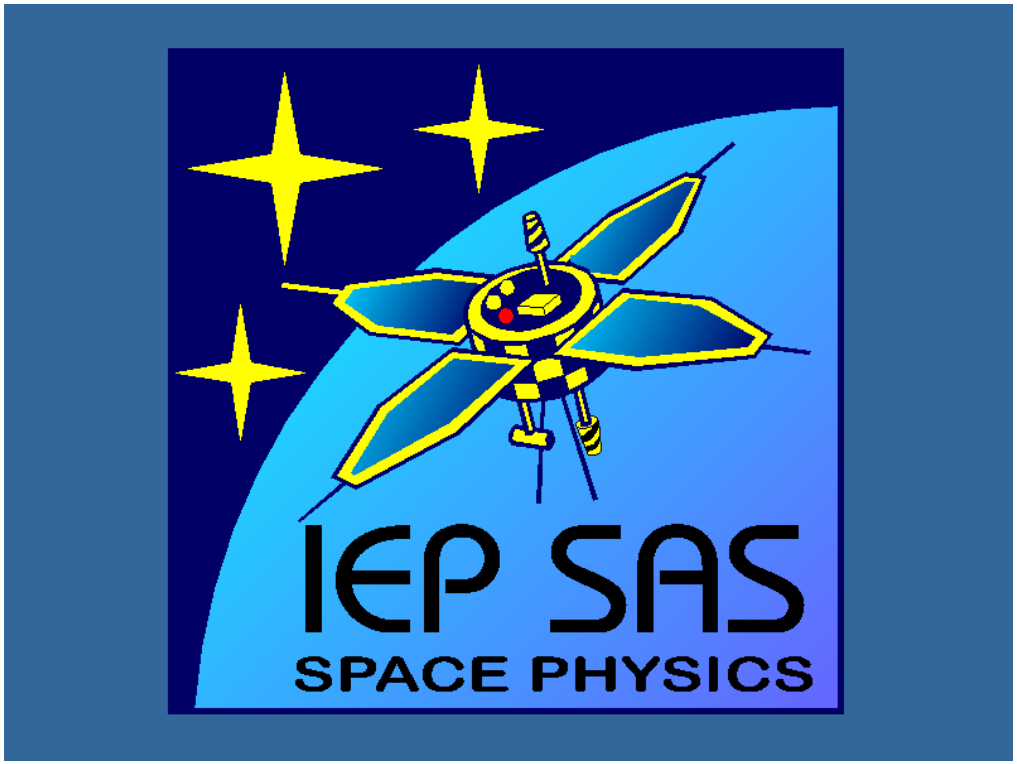
Effects of so called space weather




Measurements of the cosmic radiation at Lomnický Štít, as well as the data obtained from satellite experiments with participation of Dept. of Space Physics are investigated also in relation to the effects of the so called **space weather** :

Effects initiated by processes in the space with impacts on functionality and reliability of technological systems in satellites, aeroplanes and on the surface of the Earth, with possible influence on people, especially in aeroplanes and in the cosmic space.

The satellite measurements and analysis are done in a broad collaboration with scientists in laboratories with similar orientation as Dept. of Space Physics in many countries




**Years 2003-2006**

***Department of Space Physics, laboratory in Košice (Bulharská 2)***

***and laboratory at Lomnický Štít.***

More info at

**http://space.saske.sk**

Continuous cosmic ray measurements in real time at

# Department of Subnuclear Physics

## Our future – Large Hadron Collider at CERN

## ATLAS

## HEC - Test beam calibration

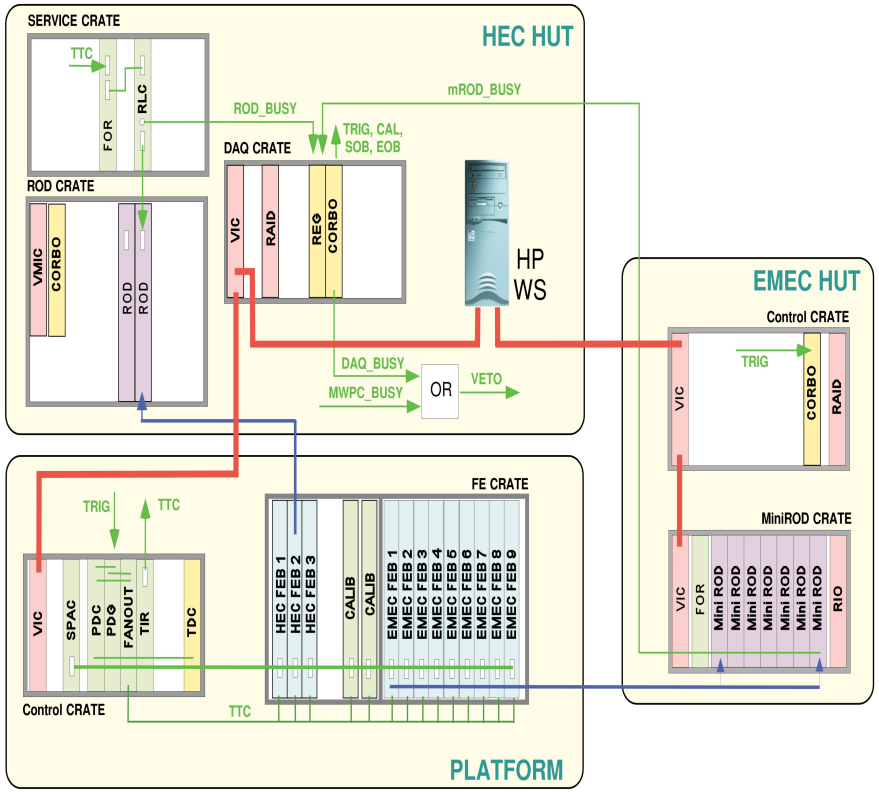



Fig. 3. Block diagram of the front-end, read-out and trigger electronics.

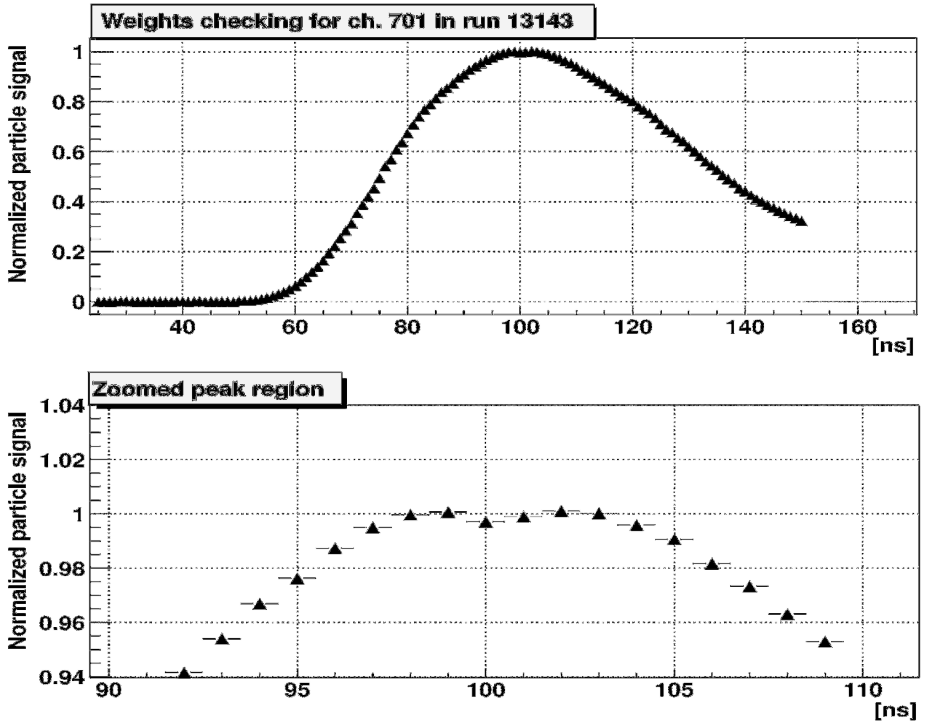
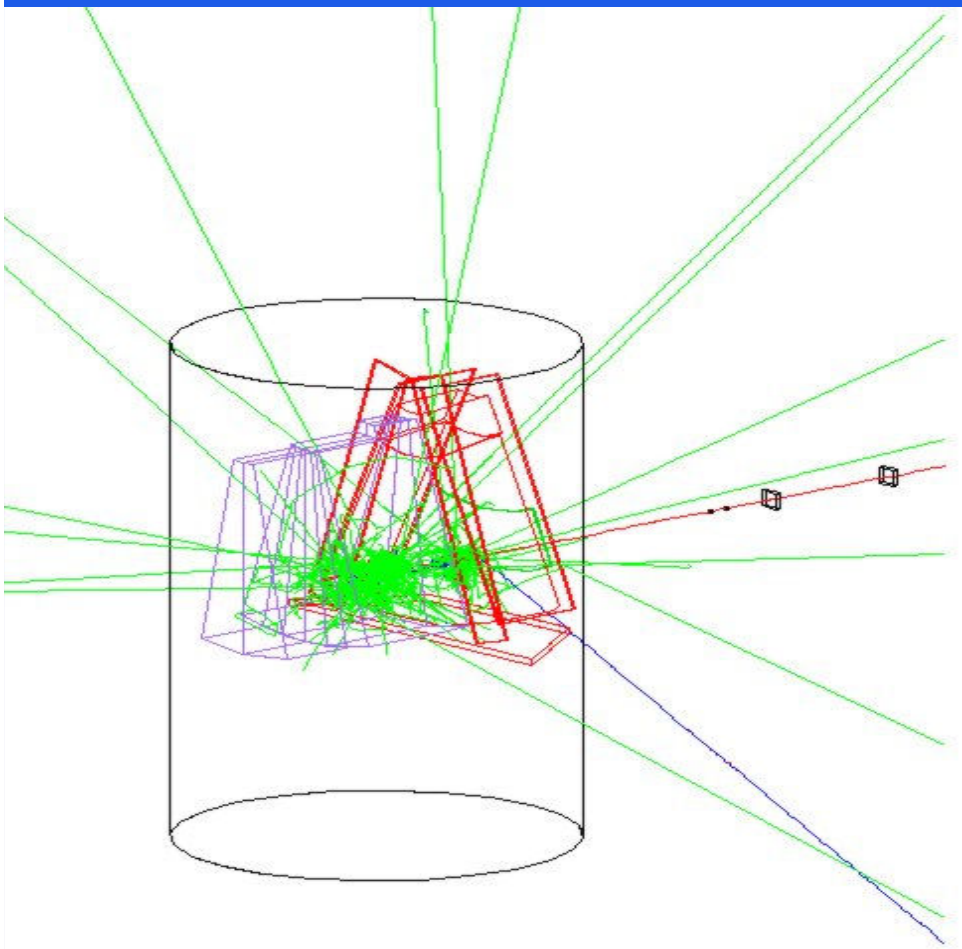


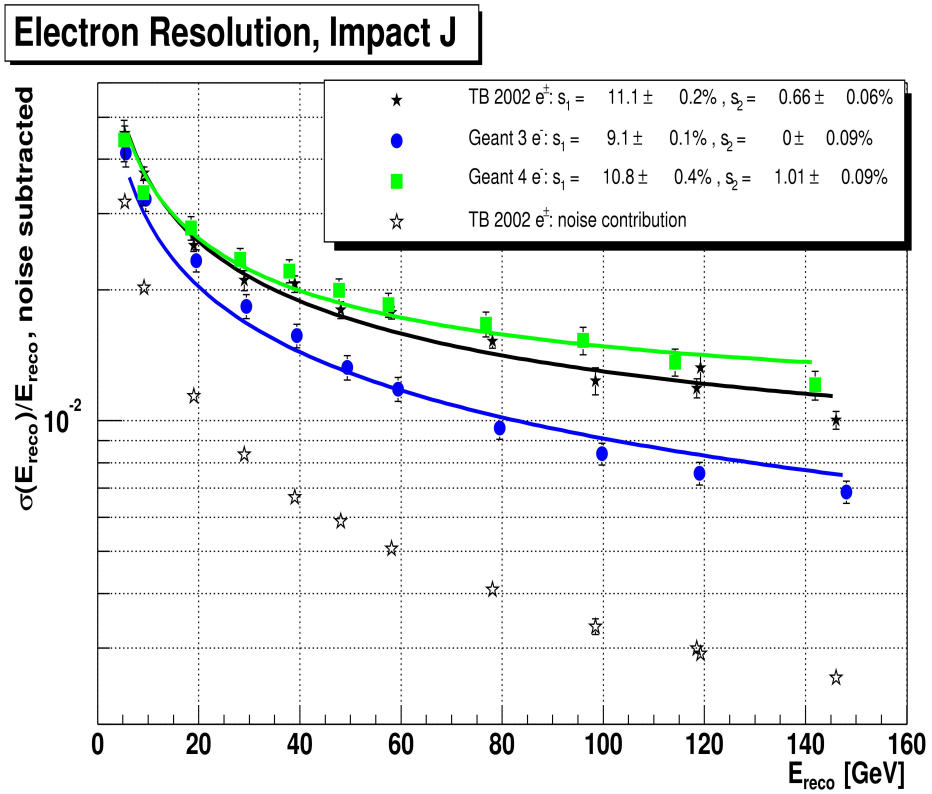

Fig. 6. Upper figure: normalized measured particle signal, using optimal filter weights computed from the calibration signal. Lower figure: close up of the peak region.

# Department of Subnuclear Physics

## Our future – Large Hadron Collider at CERN

ATLAS HEC - Test beam Monte-Carlo simulation



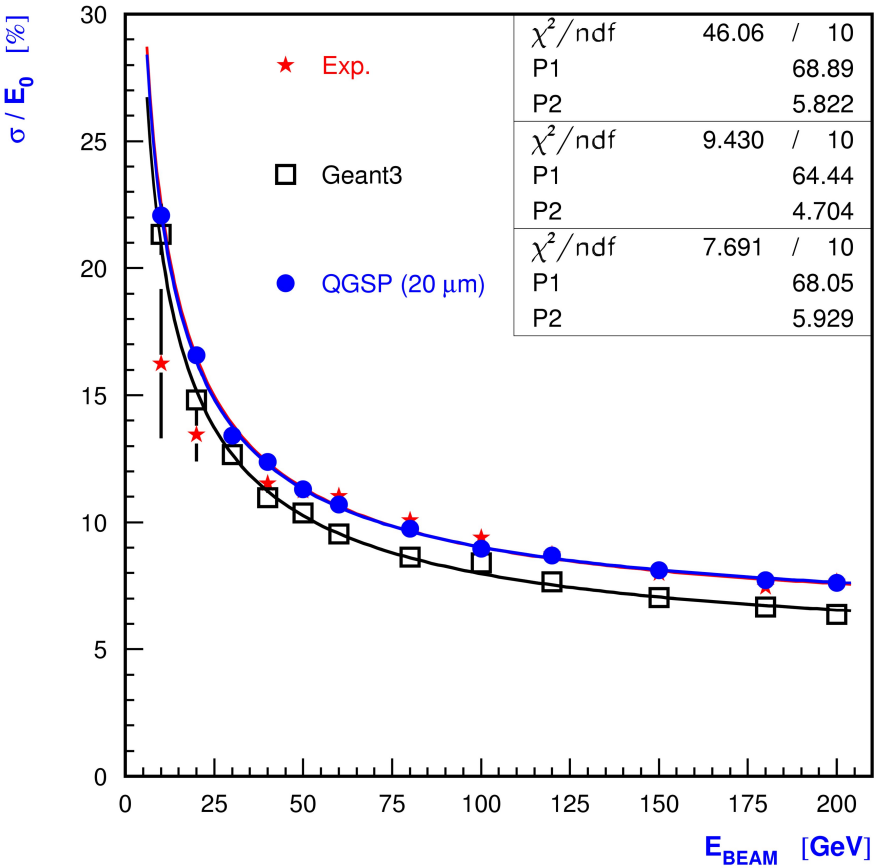


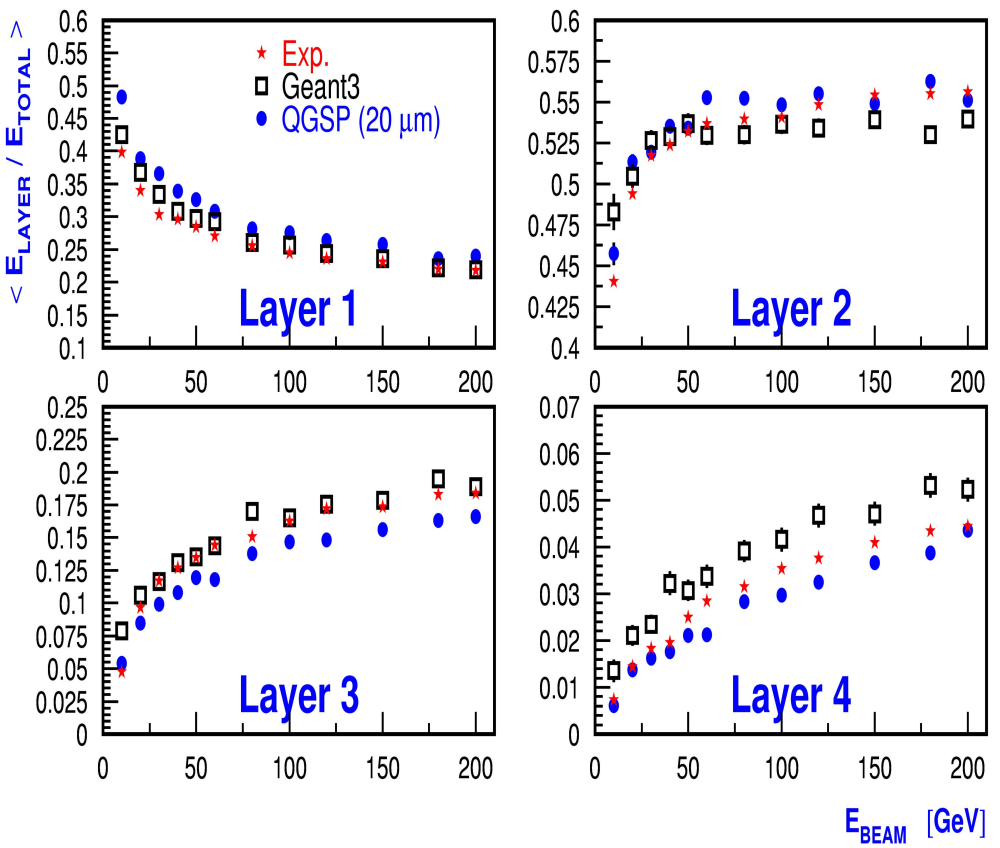
# Department of Subnuclear Physics

## Our future – Large Hadron Collider at CERN

## ATLAS

## GEANT4 physics validation



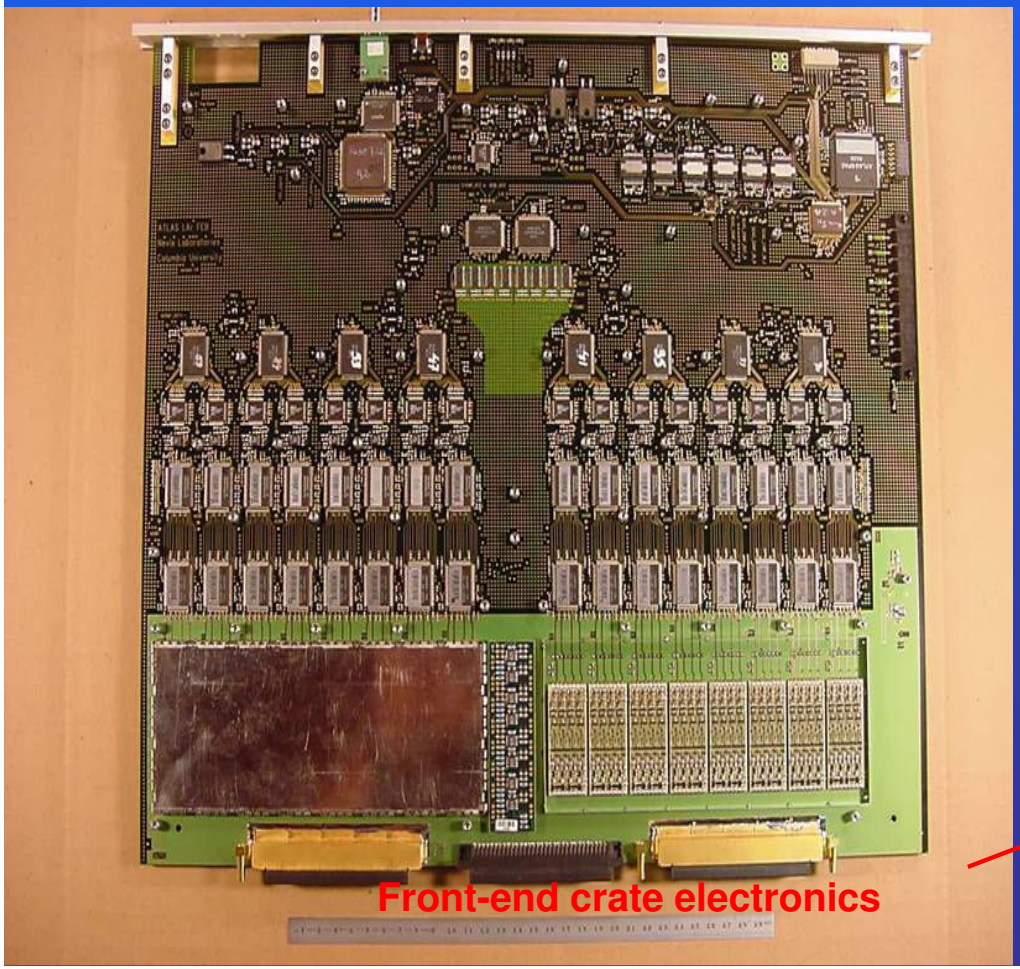



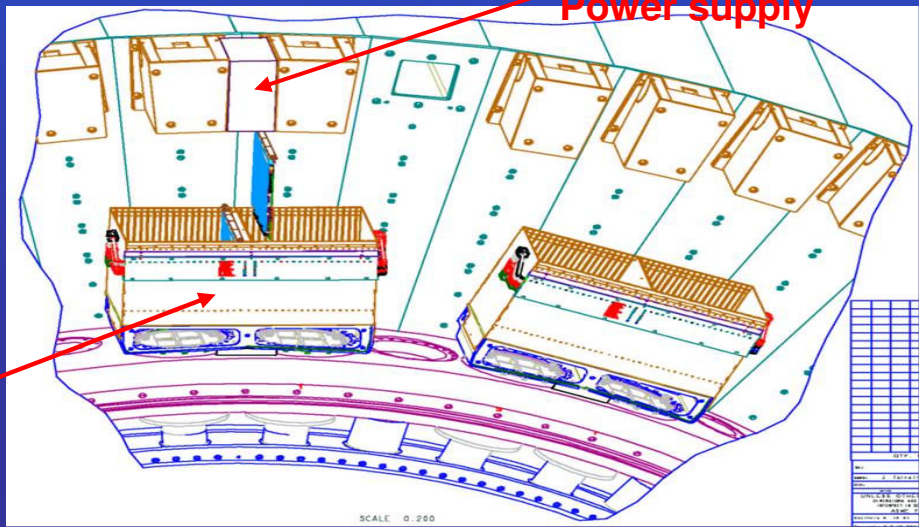
# Department of Subnuclear Physics

## Our future – Large Hadron Collider at CERN

## ATLAS

### Front-end electronics



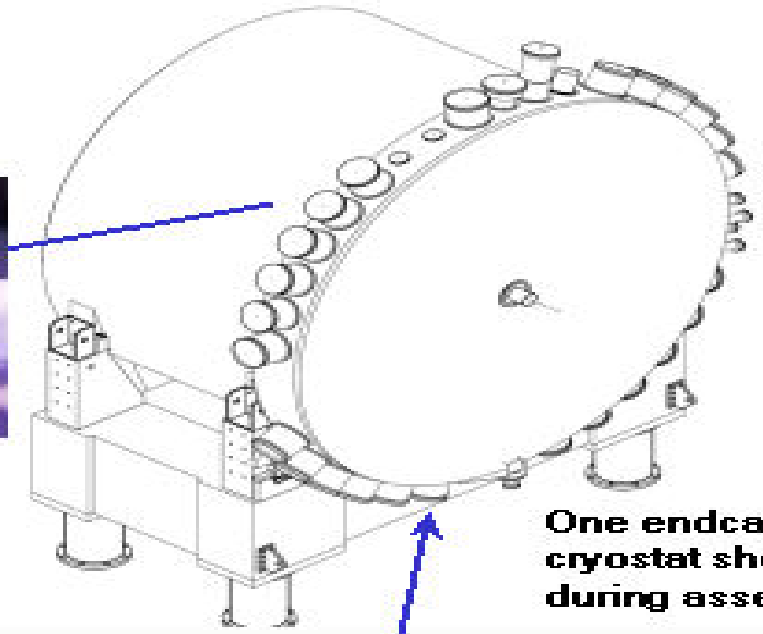



# Department of Subnuclear Physics

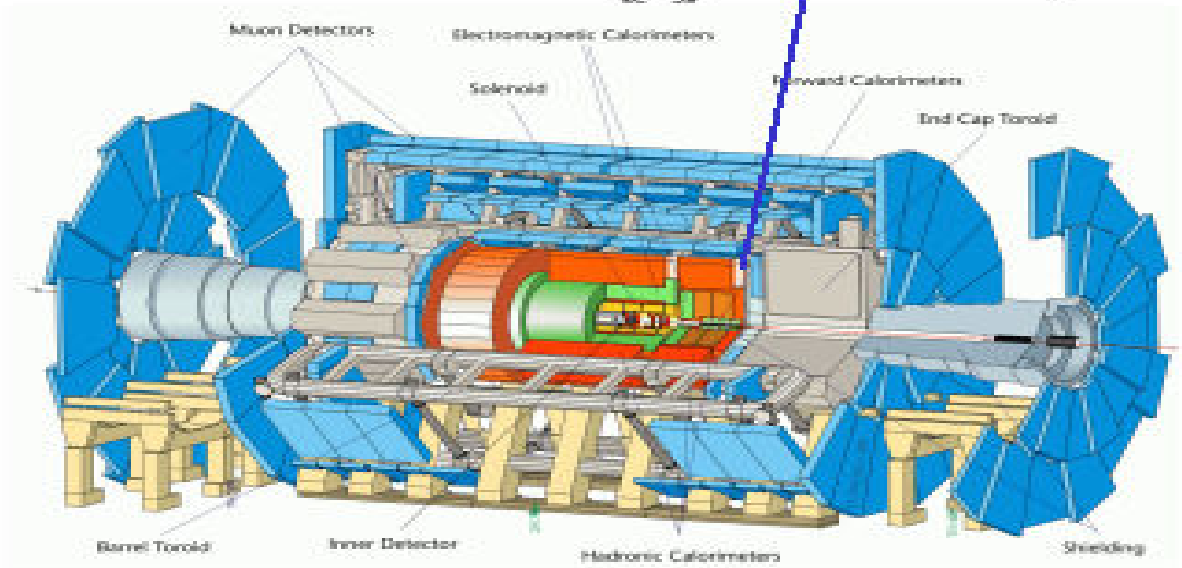
## Our future – Large Hadron Collider at CERN

ATLAS

Filter box production



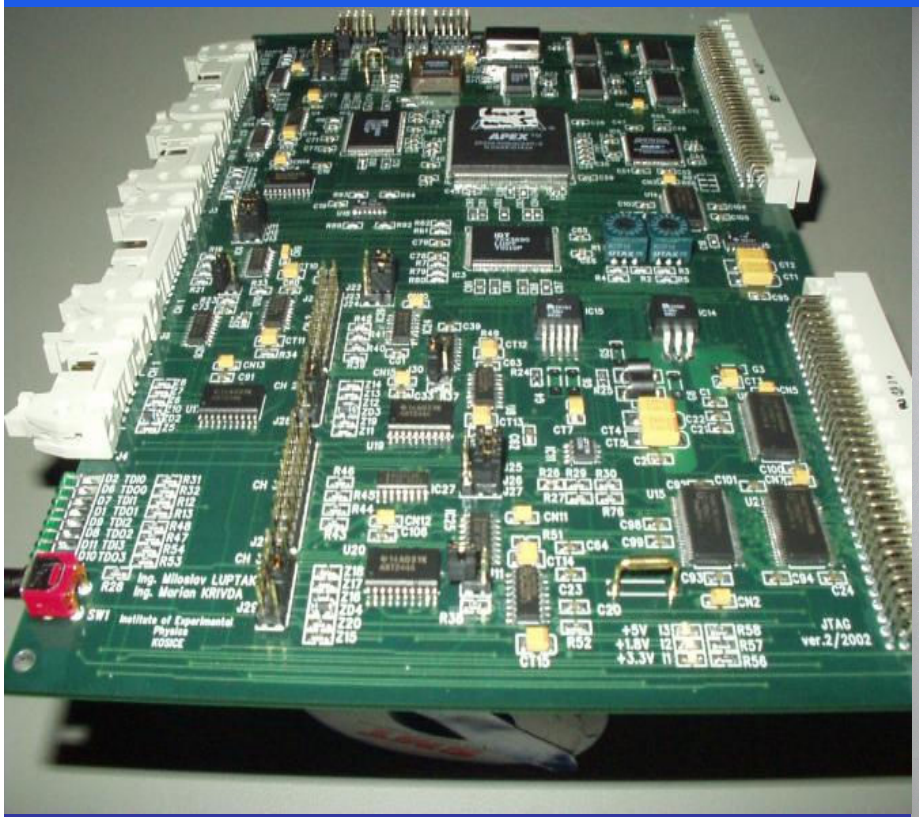
One endcap cryostat shown during assembly



# Department of Subnuclear Physics

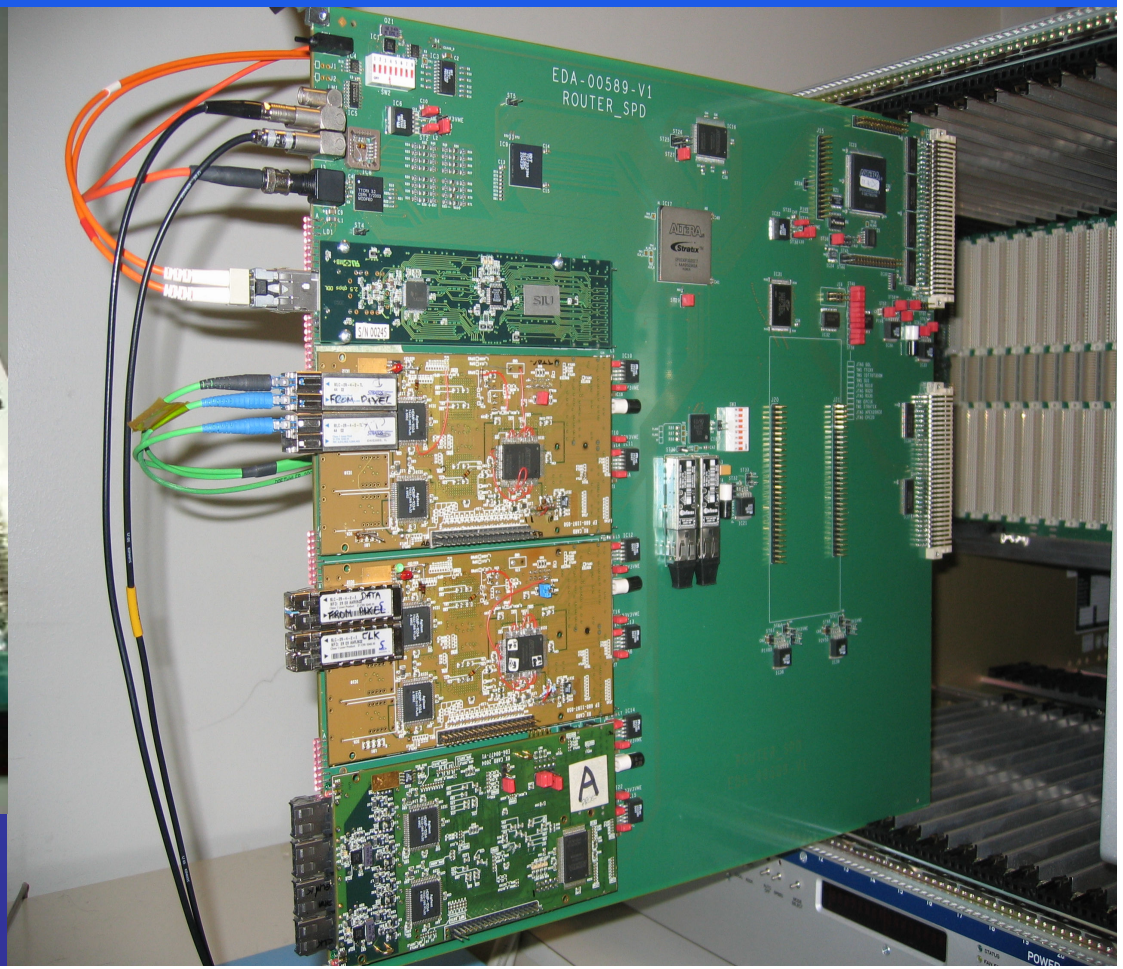
## Our future – Large Hadron Collider at CERN

ALICE




JTAG controller

Router

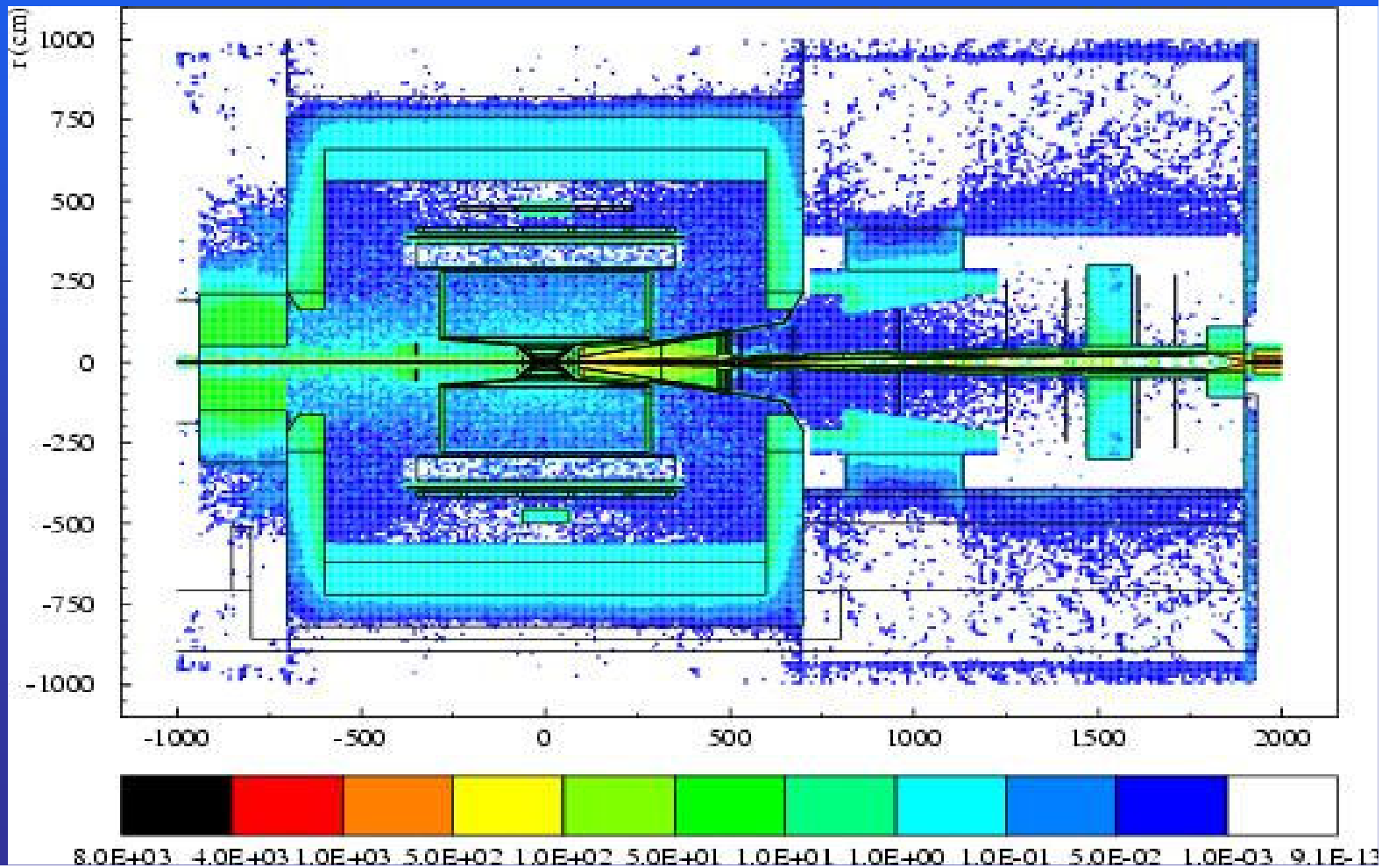


# Department of Subnuclear Physics

## Our future – Large Hadron Collider at CERN

ALICE

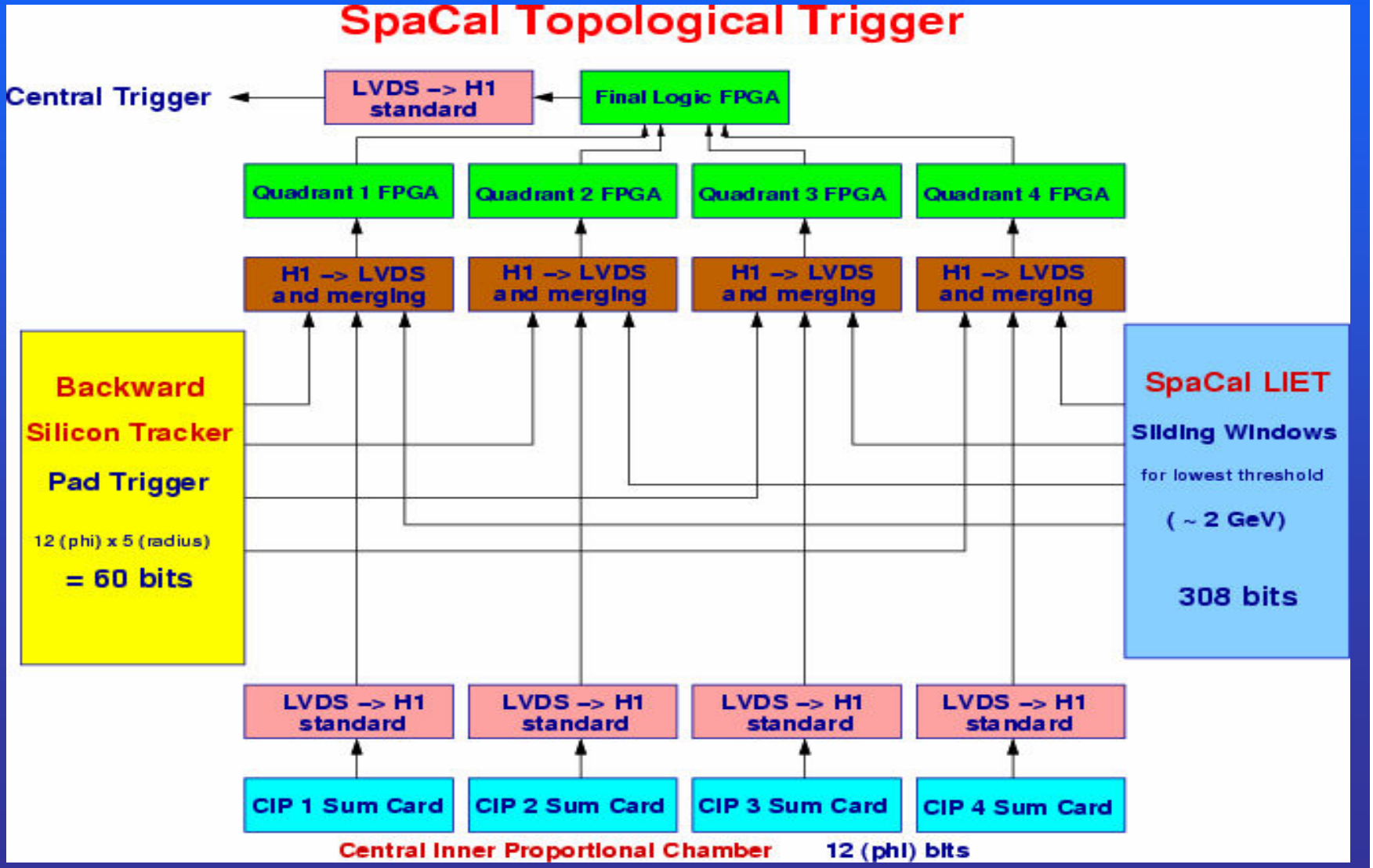
Radiation simulation



# Department of Subnuclear Physics

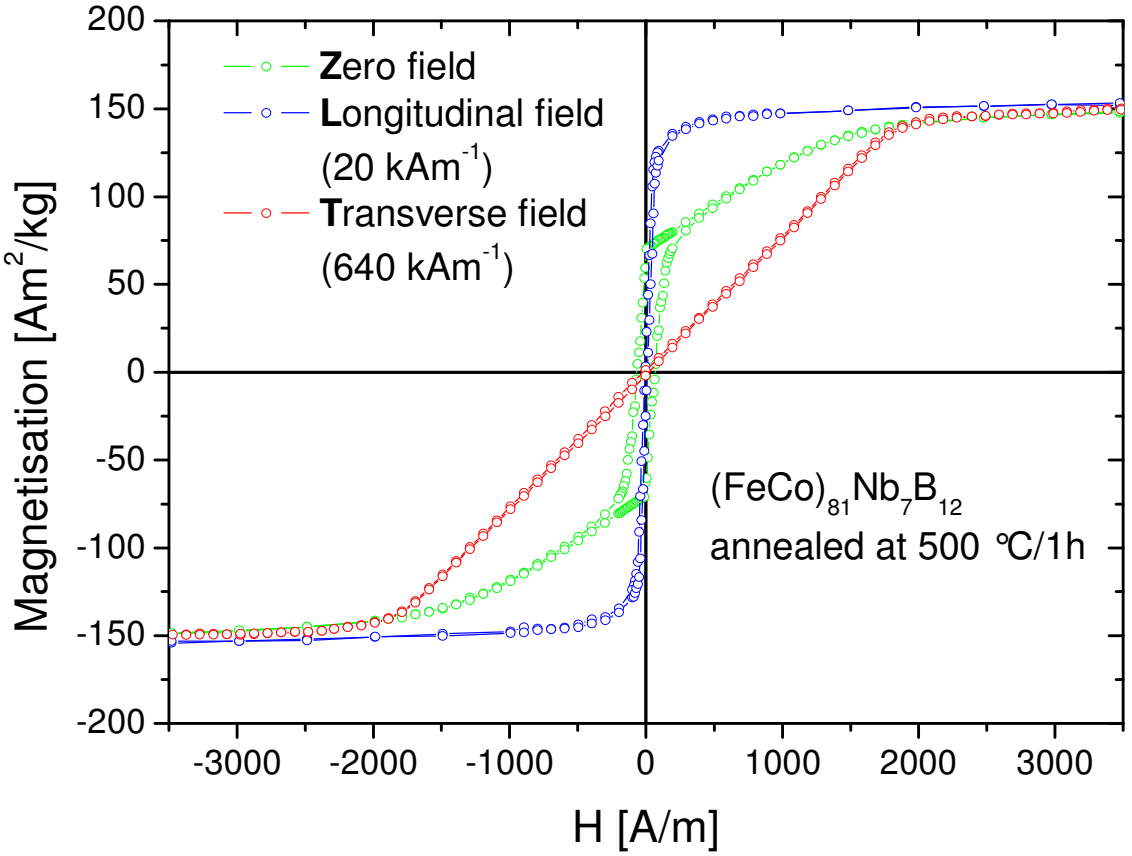
## Topological trigger for longitudinal proton structure function measurement

H1

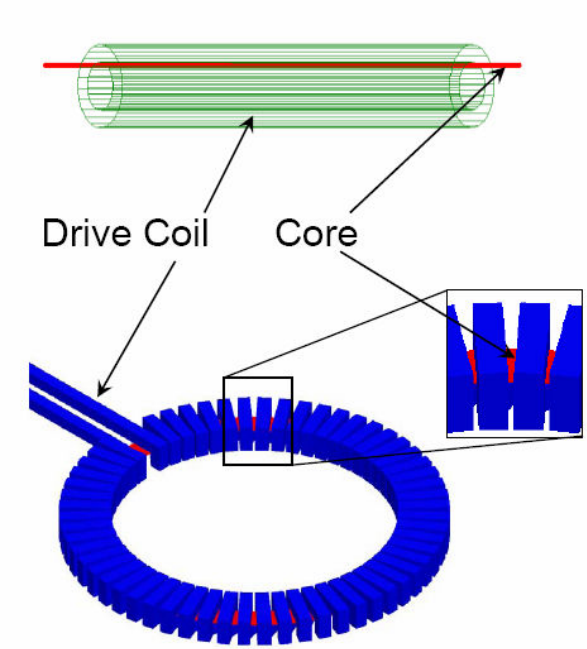


# Group of Nanostructured Magnetic Materials

- **nanocrystalline soft magnetic materials** with Fe, FeNi and FeCo grains embedded in a residual amorphous matrix




Prospective magnetic materials for active core parts of various high performance sensors




Variable Inductance

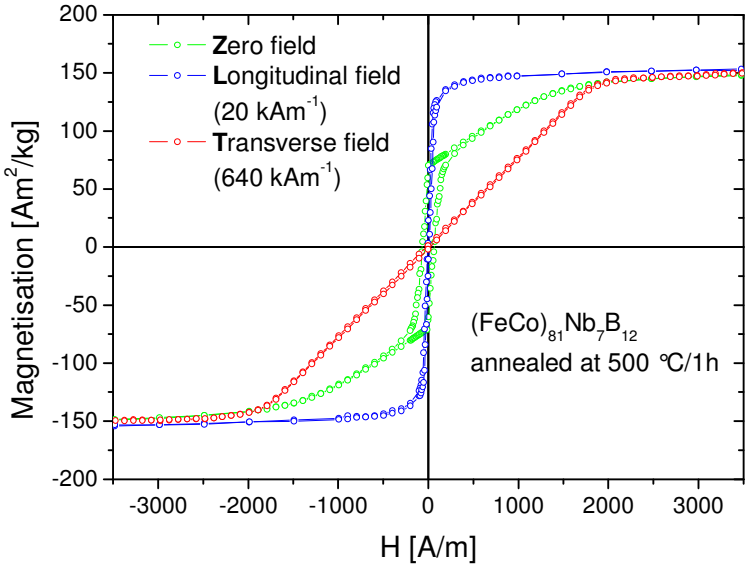
- Function of Drive Current
- Function of External Magnetic Field

Possibility to tailor the soft magnetic properties of nanocrystalline FeCo-based alloys by heat treatment in external magnetic field

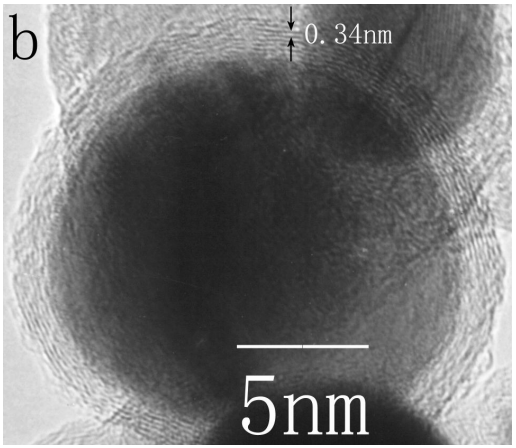
Related papers: Appl. Phys. Lett. **85** (2004) 2884, **85** (2004) 1392, J.Magn. Magn. Mat. **304** (2006) 203, **310** (2007) 2494

# Group of Nanostructured Magnetic Materials

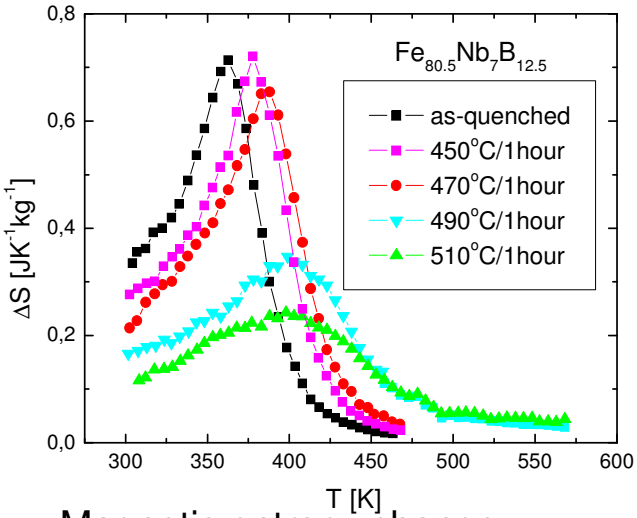
- **nanocrystalline soft magnetic materials** with Fe, FeNi and FeCo grains embedded in a residual amorphous matrix
- **magnetic nanoparticles and nanocapsules** with **core/shell** structure
- **materials for magnetic refrigeration**




Improved soft magnetic properties of nanocrystalline FeCoNbB after heat treatment in external magnetic field



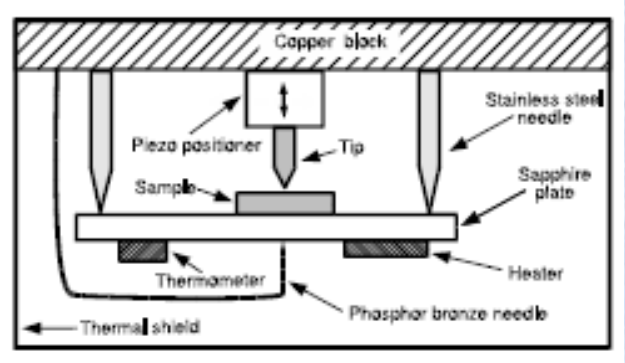

HRTEM of Gd/GdC2 nano-capsules with graphite shell



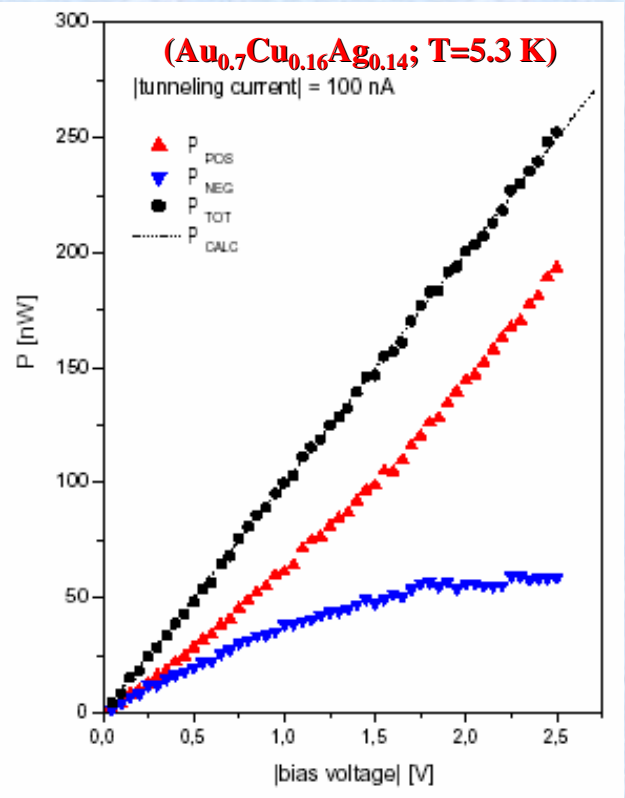

Magnetic entropy change for amorphous and nano-crystalline FeNbB

# Calorimetric tunneling experiments

**Experimental setup :**




**Experimental results :**




- **Original (world first) experiment >> the first exact calorimetric verification of the heating model for tunnel junctions (TJs).**

- **Observed asymmetrical power dissipation in individual TJ electrodes >> The flow of tunneling current results in thermal gradients!**

## PERSPECTIVE APPLICATIONS >>

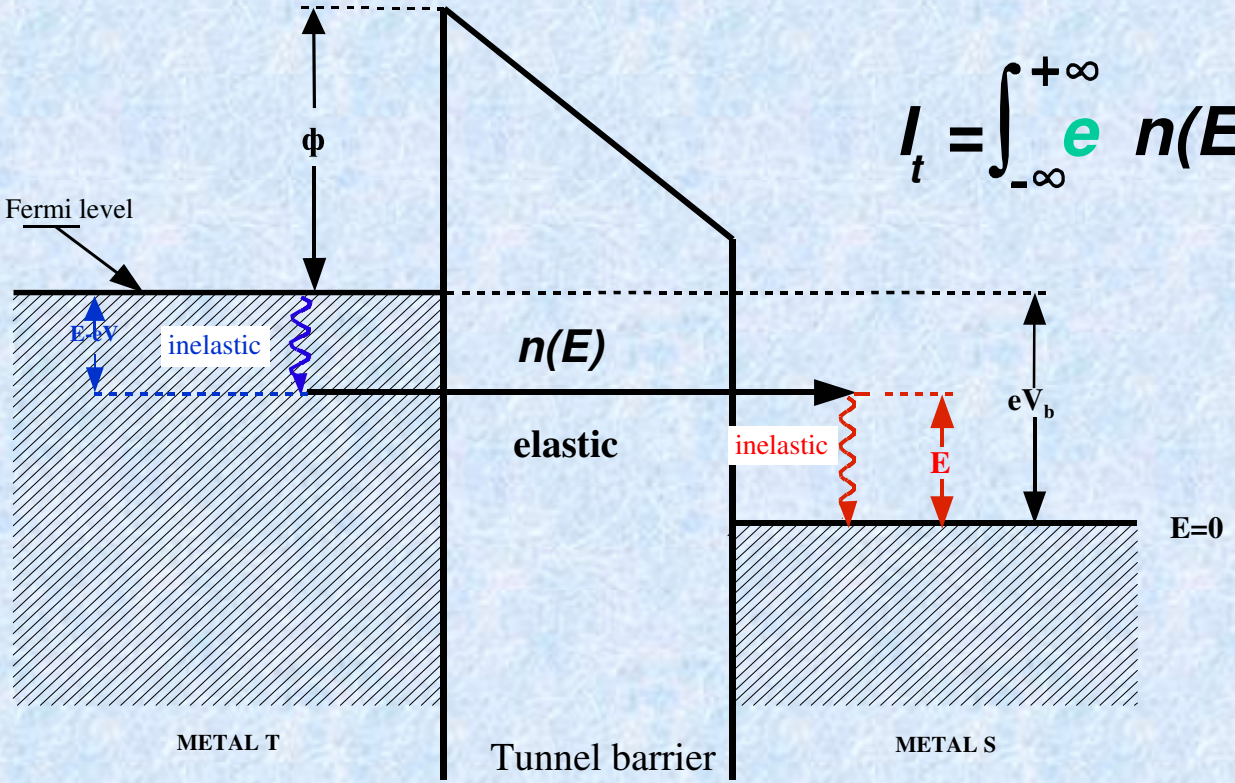
**Novel studies of thermoelectric phenonena in tunnel structures - basic & applied research:**

- **Andreev reflection, detection of light emission in TJs, electronic refrigeration**

- **R & D of materials for micro- and nano-electronics >>** elimination of thermal gradients and power dissipation in TJs **>>** improvements of electronic devices (especially unipolar)

**I. Baťko, M. Baťková, Eur. Phys. J. Appl. Phys. 31 (2005) 191**

# CTE: Model



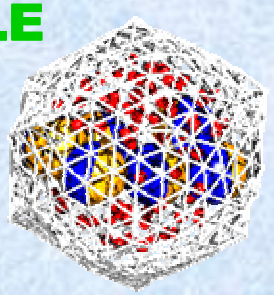

$$I_t = \int_{-\infty}^{+\infty} e\, n(E)\, dE$$

$$P_{NEG} = \int_{-\infty}^{+\infty} (eV_b - E)\, n(E)\, dE$$

$$P_{POS} = \int_{-\infty}^{+\infty} E\, n(E)\, dE$$

$$P_{TOT} = P_{POS} + P_{NEG} = V_b I_t$$

# ENCAPSULATION OF DRUG IN MAGNETIC BIODEGRADABLE POLYMER NANOPARTICLES



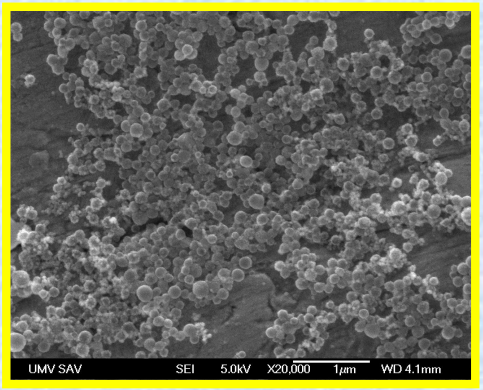
## Motivation

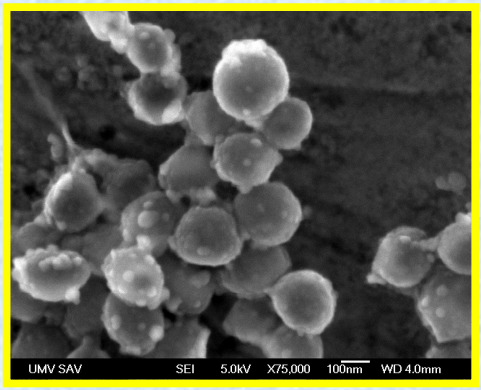
preparation of drug loaded magnetic biodegradable polymer nanoparticles (Nps) by nanoprecipitation method for targeted drug delivery

### *Preparation*

Rotoevaporator for preparing PLGA Nps

### *Characterization*




SEM pictures of magnetic PLGA nanoparticles with anticancer drug Taxol

### *Results*

magnetic response


**M.Koneracká, P.Kopčanský, M.Timko, C.N.Ramchand, Z.M.Sayied, M.Trevan, A.de Sequeira:**
***Immobilization of Enzumes on magnetic particles***
Book: Immobilization of Enzymes and Cells, 2.edition, Edited by Jose M.Guisan in Humana Press-Totowa, New Jersey, 2006, p.217
**V.Závišová, M.Koneracká, N.tomašovičová, P.Kopčanský, M.Timko:**
***Some immobilization modes of biologically active substances to fine magnetic particles.***
**Z.Phys. Chem 220 (2006) 241-250**
**M.Timko, M.Koneracká, N.Tomašovičová, P.Kopčanský, *V.Závišová:***
***Magnetite polymer nanospheres loaded by Indomethacine for anti-inflammatory therapy.***
***Journal of Magnetism and Magnetic Material 300 (2006) 191-194***

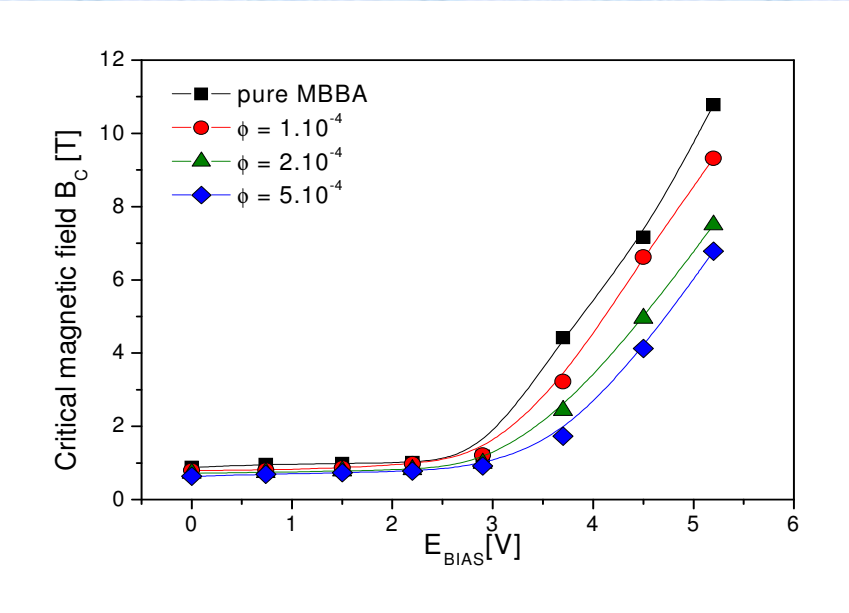
# Structural phase transitions in ferronematics and ferronematic droplets

## Motivation:

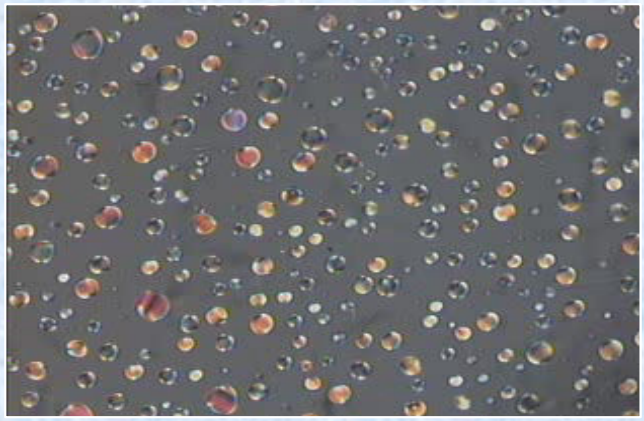
-addition of magnetic nanoparticles (MNP) to liquid crystals increases their response on the external magnetic field

## Main results:

-addition of MNP to the MBBA and 6CHBT liquid crystals decrease the value of critical magnetic field of Fredericksz transition




-as a first in the world were prepared magneticaly active droplets of liquid crystals doped by MNP

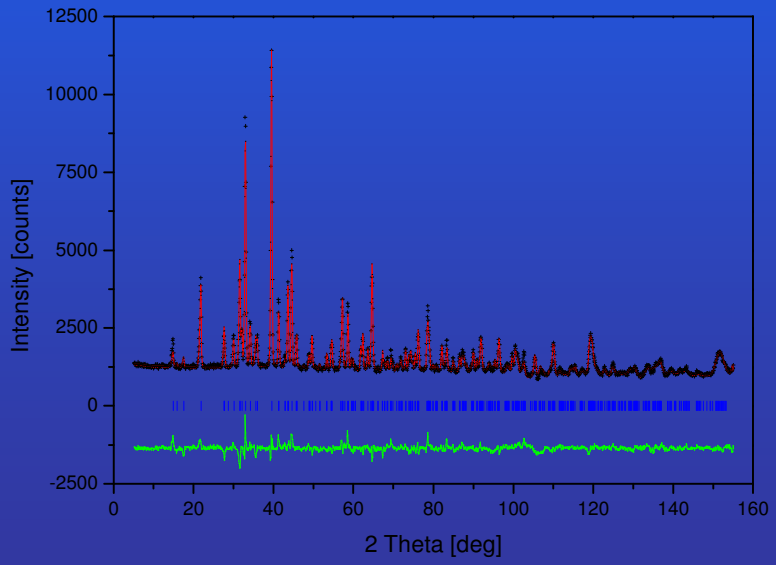


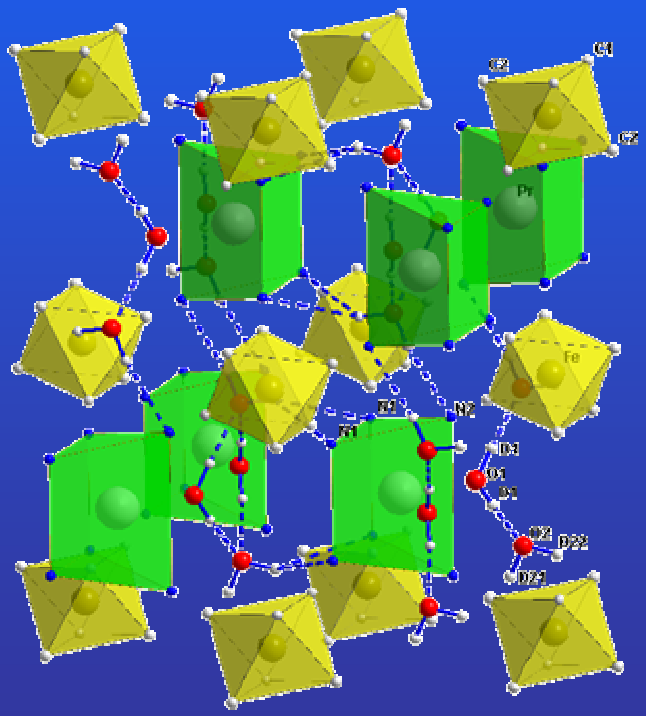

**N.Tomašovičová, M.Koneracká, P.Kopčanský, M.Timko, V.Závišová, J.Jadzyn**
Temperature dependence of critical magnetic field of structural transition in MBBA – based ferronematics
**Phase transitions 79 (2006) 595-603**
**P.Kopčanský, M.Koneracká, M.Timko, I.Potočová, L.Tomčo, N.Tomašovičová, V.Závišová, J.Jadzyn**
The structural transitions in ferronematics and ferronematic droplets
**Journal of Magnetism and Magnetic Materials 300 (2006) 75-78**
**P.Kopčanský, I.Potočová, M.Timko, M.Koneracká, L.Jansen, J.Jadzyn, G.Czechowski**
The structural transitions in ferronematics in combined electric and magnetic fields
**Journal of Magnetism and Magnetic Materials 272-276 (2004) 2355-2356**

# Refinement of crystal structure

Refinement of $Pr[Fe(CN)_6]\cdot 4D_2O$ structure by Rietveld method.

(Neutron difractogram - HMI Berlin).




Best Institute result in 2005