Ruđer Bošković Institute

Zoran Basrak



Laboratory for heavy-ion physics Division of Experimental Physics

EURONS, East-West Outreach (SEENet) Bucharest, 13 -14, May. 2005





FACTS ABOUT CROATIA

Geopolitics



Southeastern Europe, bordering the Adriatic Sea, between Bosnia and Herzegovina and Slovenia, Hungary

Location:

and Serbia (45 N, 15,5 E)

Area: 56,542 sq km

Population: 4,44 mil. (2001)



Capital: Zagreb, 970.000 (region)





FACTS ABOUT CROATIA

In each of four main **Croatian universities** there is at least some nuclear physics activity In Croatia there is about **30** (pure) nuclear physicists & about 100 nuclear & particle physicists











IRB STORY

1950 - Founded as Institute for atomic research with four departments: Theoretical phyiscs, Molecular physics, Nuclear physics and Electronics 1952 - Department of chemistry 1954 - Department of biology 1956 - Launched home-constructed Cockroft-Walton accelerator used as neutron generator 1957 - IRB researchers launched the first

postgraduate studies in former Yugoslavia

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IRB STORY

1962 - Launched home-constructed 16 MeV-proton cyclotron, used mainly for production of up to 75 GBq/year of medical radioisotopes



1969 - Center for Marine Research joined the Institute; eco & environmental research





nstitute - 1950



1987 - Installed HV EN tandem Van de Graaf accelerator (donated by Rice University, Texas)





IRB STORY

1990 - New building for molecular biology & genetics department

2001 - Opened new NMR Centre

2003 - High capacity IRB network & the new Centre for Informatics and Computing

2004 - Installed 1MV Tandetron accelerator. Commissioning started (project supported by IAEA)



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IRB TODAY

The Institute is a multidisciplinary and interdisciplinary research center for fundamental & applied research in physics electronics & computing chemistry biology & medicine environment & marine in 5 departments 12 divisions 2 centers



IRB TODAY – employees

At the end of 2004 the Institute had almost 800 employees out of which about 650 in departments. Within the research stuff 530 employees are with an academic degree.



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nstitute - 1950



338 with Ph.D. degree
71 with M.Sc. degree
122 with B.Sc. degree



IRB TODAY – physics at IRB

Physics Department

- Theoretical Physics Division
- Division of Experimental Physics
- Division of Materials Physics
- Division of Laser and Atomic Research & Development
 RESEARCHERS BY BRANCHES



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IRB TODAY – research support

Computing

Besides about 500 PCs at IRB at disposal to users are computing clusters, the local one and a national one at the University of Zagreb computing center.

 Network & Internet
 Local network is of 0.1 Gb/s capacity, while outside connection is 1 Gb/s allowing a comfortable work in remote mode with leading role in CRO-GRID project.



nstitute - 1950



IRB library



National

- 123 Fundamental research projects
 - 33 Technology projects
- 135 Contracts with industry

International

- >500 collaborations (research partners world wide)
- 59 bilateral & multilateral research projects
- Dozen of EU FP5 & FP6 signed projects



 Strong financial NATO, IAEA & Norway support



IRB Division of Experim. Phys.





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Division of Experimental Phys.

People



35 – PhD (3 retired)13 – Ph.D. students

9 – technicians & operators (1 retired)

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Division of Experimental Phys.

- Projects
- 11 National fundamental research projects
 - 8 IAEA projects
 - 4 EU FP5 & FP6 projects
 - 1 NATO project
 - Collaborations
 - FOPI, CBM (GSI), Crystal Ball (MAMI)
 - NA49, ATLAS, CMS, CAST (CERN)
 - PRISMA (LNL), CHIMERA (LNS), CRC Louvin-la-neuve, KVI Groningen, IJS Ljubljana, SUBATECH Nantes, IReS Strasbourg, ...



Division of Experimental Phys.

- Problematics
- nuclear structure and reactions
- nuclear matter at extreme conditions
- elementary particles and astroparticles
- QCD (Q-G plasma) & beyond (axions)
- fundamental interactions & symmetries
- R&D of nuclear techniques & their applications
- education



Strictly within NuPECC recommendations





Division of Experimental Phys.

- Relevant experimental equipment
- HV EN Van de Graaf
- 1 MV Tandetron Van de Graaf
- Cockroft-Walton accelerator serving as neutron generator (commercial, Texas Inc.)





Large volume Liquid Scintilation Counter for ¹⁴C & tritium (IAEA donation)



EURONS East-West Outreach – SEENet

Croatian partners



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SEENet Zagreb partners

Ruđer Bošković Institute Laboratory for nuclear reactions Project: Light nuclei: clusters, nuclear molecules, reactions Laboratory for heavy-ion physics **Project: Heavy-ion physics** Laboratory for ion beam interactions **Project:** Fast ion-matter interaction processes



University of Zagreb



Theoretical Nuclear Physics Group Physics Department, Faculty of Sciences





Institute - 195



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Division of Experimental Physics

Lab. for nuclear reactions

People

Scientific: Dr. **<u>Duro Miljanić</u>**, head & **<u>project leader</u>** senior scientist Dr. Mile Zadro, senior research associate Dr. Saša Blagus, senior research associate Dr. Neven Soić, research associate Dr. Matko Milin, research associate **Technical: Mladen Koncul** Kasim Kovačević

G.







Lab. for nuclear reactions

Research activities

Nuclear structure Clustering in light nuclei Halo nuclei, exotic structures Nuclear molecular configurations

Nuclear reactions Reactions with light nuclei Nuclear astrophysics Trojan Horse Method

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Lab. for nuclear reactions

Contracts

Croatian Ministry of Science

International collaborations
 Belgian (Louvin-la-Neuve)
 Germany (Berlin)
 Great Britain (Birmingham)
 Italy (Catania)

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People

Lab. for heavy-ion physics





Scientific: Dr. Roman Čaplar, head, senior scientist Dr. Zoran Basrak, project leader, senior scientist Dr. Suzana Szilner, research associate Dr. Mladen Kiš, senior assistant Igor Gašparić, PhD student Ivan Novosel, PhD student



Research activities

Low energies Properties of nuclear surface multinucleon transfer reactions exotic structures nuclear rainbow

Reaction mechanism fusion-fission & quasifisson

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eratorij za teškolonsku fiziku

Research activities

coincidences

Intermediate energies, Fermi energy Nuclear matter properties In-medium effects Binary dissipative collisions interplay of the nuclear mean field and residual n-n collisions

Proton virtual bremsstrahlung & $\gamma - \gamma$

Intermediate energies, elementary collisions







oratorij za teškolonsku fiziku

Research activities

Relativistic energies, heavy-ion reactions Asymmetric systems ordered motion of nucleons better participant / spectator resolution Isospin dependence production of charged pions entropy production Strange meson production strange mesons at threshold

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Research activities

Relativistic energies, pion reactions Strange meson production Ultrarelativistic energies Compressed Barion Matter (CBM)



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Contracts

Croatian Ministry of Science

International collaborations France (Strasbourg, Nantes) Germany (Darmstadt, Berlin) Italy (Legnaro, Catania) The Netherlands (Groningen) Finland (Jyvaskyla)







People

Scientific:

Dr. Milko Jakšić, head & project leader

senior scientist Dr. Stjepko Fazinić, research associate Dr. Iva Bogdanović Radović, research associate Dr. Zvonko Medunić, research associate Željko Pastuović, PhD student Zdravko Siketić, PhD student Marko Karlušić, PhD student

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People

Technical:

Natko Skukan, chief operator Mladen Bogovac, acquisition & control software Željko Periša Andrija Gajski



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Accelerator centre HV 6 MV EN tandem: Two ion sources: alphatrons and sputtering **Five experimental lines:** a) Two experimental lines for in-beam nuclear analytical methods (equipped with X-ray, γ -ray & solid state detectors) for PIXE, PIGE, RBS, NRA & ERDA b) Experimental chamber for nuclear reactions c) Experimental line for material modification d) Nuclear microbeam of high standard



 Accelerator centre HV 6 MV EN tandem: Main users:

> Laboratory for Ion Beam Interactions, IRB Laboratory for Nuclear Reactions, IRB International Atomic Energy Agency



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 Accelerator centre **HVEE 1 MV Tandetron:** Multi purpose 1 MV medium current Tandetron accelerator system capable of upgrading to high current **High current stability Two ion sources:** duoplasmatron and sputter **Projects:** - AMS

- Materials modification with ion beams

- Ion implantation

- Institute 1950





Research activities

Charge collection properties of radiation detectors

High energy physics detectors / radiation damage

CZT characterisation

Charge collection of SiC

Charge transport and defects

Defects in silicon (crystal and polycrystalline) Amorphous silicon solar cells







Research activities Light element analysis **IAEA Coordinated Research Project Development of techniques New ERDA set-up** Zero degree line with PIGE + ERDA + 2*RBS Analysis of WC thin films Art and archeometry Routine analysis of paint layers, ceramics, stones, alloys etc. Chinese porcelain studies



Contracts

Croatian Ministry of Science International Atomic Energy Agency (4 contracts)

International collaborations China Italy Japan USA

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Theoretical Nuclear Physics Group

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(INV)

Theoretical nucl. phys. group

People

Scientific:

Prof. Dr. Dario Vretenar, full professor Prof. Dr. Slobodan Brant, full professor Dr. Robert Pezer, senior assistant Dr. Tamara Nikšić, senior assistant Vladimir Krstić, PhD student Tomislav Marketin, PhD student



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Theoretical nucl. phys. group

Research activities

Nuclear structure models, effective relativistic field theory and density functional theory

Minimal covariant models for nuclear structure studies

- non-linear meson-exchange models

- non-linear point-coupling models
- density-dependent hadron field approach beyond mean-field: pairing correlations
- relativistic Hartree-Bogoliubov framework
 relativistic RPA



Theoretical nucl. phys. group

Research activities

QCD inspired formulation of the nuclear many-body problem - a covariant framework based on effective field theory and density functional theory Theoretical investigation of nuclei far from the valley of beta-stability Theoretical guidance and support for the field of radioactive nuclear beam physics

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Theoretical nucl. phys. group

Contracts

Croatian Ministry of Science

International collaborations
 Germany (Munich, Darmstadt)
 Greece (Thessalonica)
 Italy (Bologna, Legnaro, Camerino)

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Nuclear physicists from Zagreb that are part of the East-West Networking N4 are also involved in the INTAG JRA of the **EURopean Nuclear Structure Integrated Infrastructure Initiative** and in the CBM JRA of the **Hadron Physics Integrated Infrastructure** Initiative





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Ruđer Bošković Institute **Overhead in 2001 (same for 2002)** 2,1 M EUR Normalized per all research stuff with an academic degree 4,4 k EUR / rscrh Normalized per researcher with PhD 6,7 k EUR / PhD



Financial aspects

For IRB researchers of above 3 projects

2001 2002/1-10 **Projects:** 51 kEUR 62 kEUR Instrumentation: 2001 2002/1-10 94 kEUR 142 kEUR Other income: 2001 2002/1-10 55 kEUR 10 kEUR 2002/1-10 Brutto salaries: 2001 284 kEUR 242 kEUR Estimated overh:2001 2002/1-10 70 kEUR 70 kEUR **TOTAL:** 554 **kEUR** 526 **kEUR**

