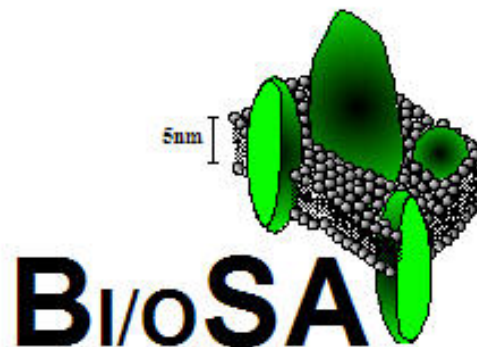




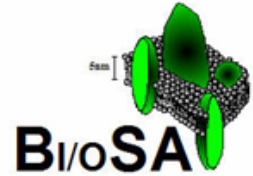
## **Strong Point Initiative (Aufbauschwerpunkt)**

### ***Biosystem Analysis (BIOSA)***

**of the  
Faculty of Natural Sciences and Engineering  
of the  
Johannes Kepler University Linz**



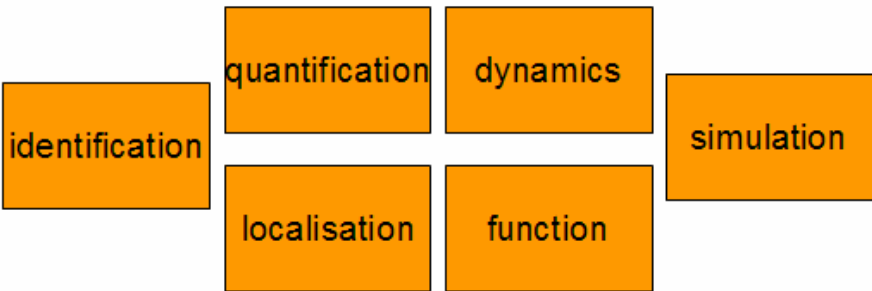
This concept is the outcome of five meetings of the BIO/SA-Team (Bauer S., Buchberger, Mühlbacher, Müller, Romanin, Titulaer) and contains also the input of two external scientific experts (Prof. S. Petersen, Denmark; Prof. H. Oberleithner, Germany).



**Strong Point Initiative  
BioSystem Analysis (BIO-SA)**

**Research focus**  
Information Transfer in  
Biological Systems

**Characterization of transfer units**

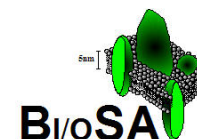


**Applications**  
Biosensors, Diagnostics,  
Tissue Engineering,  
BioNanoTechnology

- 1. Introduction**
- 2. Current Status**
- 3. Strategic Objectives**
  - 3.1. Research
  - 3.2. Teaching
  - 3.3. Organisation
  - 3.4. Personnel
  - 3.5. Investments
  - 3.6. Time-table
  - 3.7. Networks



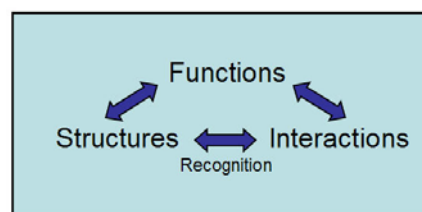
**Strong Point Initiative *BioSystem Analysis (BIOSA)***  
*Information Transfer in Biological Systems*



**1. Introduction to the topic/relevance of the scientific field**

Life sciences and here the employment of new biotechnologies are considered as one of the most promising areas in the future. In the 6<sup>th</sup> Framework Programme of the EU, 20.9% of €17.5 milliards is allocated to the area of life science, genomics and biotechnology for health. According to a report on the competitive ability in Europe (2001) the European biotechnology market alone could reach a volume of over 100 milliards Euro up to the year 2005. Providing basic science to support the bio-industries is central to the initiative presented here.

The *Strong Point Initiative Biosystem Analysis (BIOSA)* is conceived as a multidiscipline focus in research and teaching at the University of Linz. Understanding the complexity of *biological communication* is key to achieving an integrative view of biology and will allow us to better control biological processes. The up-to-dateness of this topic is underscored by the recent (December 2002) establishment of the *Alliance for Cellular Signaling* ([www.signaling-gateway.org](http://www.signaling-gateway.org)) in USA. The initiative presented here deals with the analysis of interacting components in biological systems both at the molecular and cellular level. The fundamental components of the cell (e.g. proteins, lipids and nucleic acids) have been characterized to a large extent, chemically and physically. To understand their function, the complex organization of these cell components needs to be unravelled. Specific *recognition* between the interacting components is a prerequisite for physiological processes to function in a coordinated way.



The resolution of *in vivo* information transfer functions is considered crucial for the understanding of the molecular bases of cellular processes. It remains to be established by which fundamental modes the molecular components interact and transfer information in the network. In the context of *BIOSA*, biological systems will be analyzed both by experimental and theoretical methods. Starting from basic science, applications will be developed to support the bio-industries in various areas such as improvement of diagnostic capabilities and generation of sensitive biosensors that will finally enable causal treatment of diseases at an earlier stage.

## 2. Current status of the research located at the University in Linz

The relevant core competences at the Faculty of Natural Sciences and Engineering are focused on sophisticated experimental techniques on the one hand, and specific areas of biomolecular systems, on the other hand. This know-how, which is predominantly found in the *research groups of chemistry and physics institutes*, offers an outstanding basis for the analysis of molecular biosystems and the transfer of information within and between them (e.g. multi-protein complexes). The essential basic equipment for experimental biotechnologies is established. The coordinated synergistic application of these modern biophysical and analytical techniques enables a detailed analysis on different levels of structural resolution, ranging from complex multi-molecule ensembles to single molecules.

The *quality of biomedical research* at the University of Linz ranks high within the twelve Austrian academic institutions, as has been shown in an evaluation of Austrian Biomedical Research Outputs 1991-2000 that has been ordered by the ministry of education, science and culture. This study has been published in November 2002 ([http://www.bmbwk.gv.at/medien/8032\\_lewison\\_studie\\_4net.pdf](http://www.bmbwk.gv.at/medien/8032_lewison_studie_4net.pdf)) and lists the biomedical research of the University of Linz comprising mainly that of the *chemistry and biophysics institutes* on **place 3** with respect to the quality (impact factor) of publications, when compared with the eleven other Austrian universities.

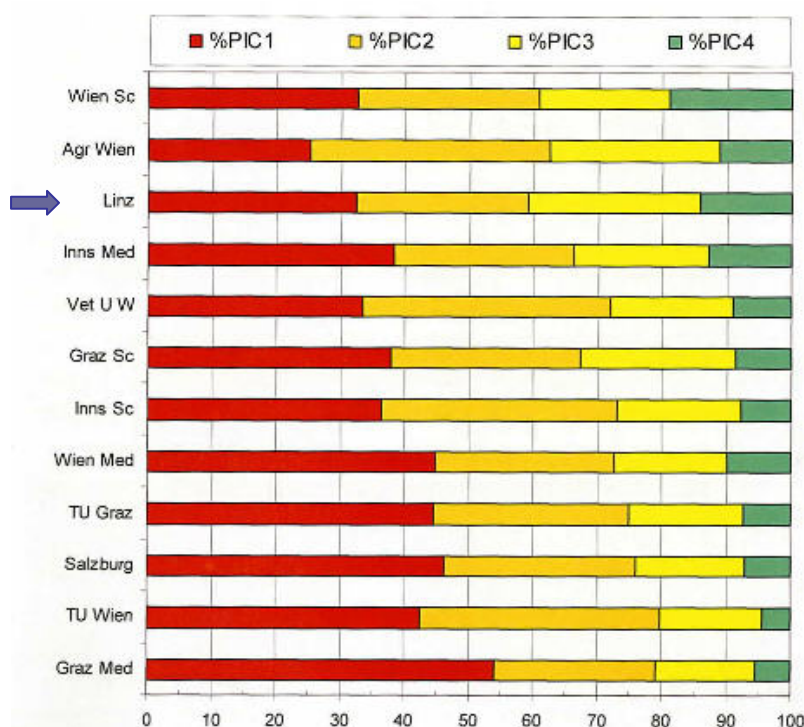


Figure 4.8 Distribution of potential impact category (PIC: 1 = low, 4 = high) for papers from the 12 Austrian university faculties: 1 = 1991-95, 2 = 1996-2000

This evaluation clearly underscores the *excellent potential* of the existing biomedical groups at the University of Linz.

In the following the activities of the participating institutes will be shortly described.

At the **Institute for Biophysics** three highly sensitive techniques (fluorescence microscopy, AFM and Patch Clamp) are established for the analysis of biological systems, particularly of life cells. Additionally, novel surface chemistry and heterobifunctional crosslinkers are developed there. This institute possesses a leading position particularly with its single-molecule microscopy techniques (SDT, MRFM)<sup>1</sup>. This has led to the establishment of the “Austrian Center (now Schindler Memorial Center) for Single Molecule Microscopy” in 1998. This center was created within the framework of three research contracts of the Austrian Federal Ministry in order to make the potential of the developed single molecule microscopy techniques accessible for Austrian life sciences, medical sciences and the industrial research.

In extension of the bio-technological developments of and in association with the Institute for Biophysics, the Center of Biomedical Nanotechnology was established here in Linz in 2002 based on a 3-year funding by the local government of Upper Austria.

The Institute for Biophysics organizes the international top-class Winterworkshop on single molecule techniques, which was meanwhile held five times (since 1999) here at the University of Linz.

Further, in the context of the Austrian GENAU-program (Gene Research Austria, 2003-2011) and under coordination of the Institute for Biophysics, a consortium of ten multidisciplinary joint-projects was established in 2003, in which beside non-university partners, the university research areas of physics, mathematics (**Fuzzy Logic Laboratory**) and mechatronics (**Institute for Electrical Measurement Technology**) are involved.

In addition, cooperation of the Institute for Biophysics exists with the **Institute of Theoretical Physics** (development of mesoscopic models for the interaction between biomolecules to simulate and analyze MRFM data), with the **Institute of Experimental Physics, Department of Atomic Physics and Surface Science** (development of a controller for sensing proteins and of a recognition box), with the **Institute of Experimental Physics, Department of Applied Physics** (cell-coating of surface-modified materials for vascular prostheses) and with the **Institute of Experimental Physics, Department of Soft Matter Physics** (biospecific sensors for label-free detection).

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<sup>1</sup> SDT: Single Dye Tracing; MRFM: Molecular Recognition Force Microscopy  
Coordinator: C. Romanin

The Institute for Biophysics is well equipped with high-end devices and instruments, however, basic infrastructure equipment needs complete renewal.

The Institute for Biophysics has recruited ~3.5 million Euro of external funding in the last 3 years.

The instrumental methods and specific know-how established in the **chemistry research units** mainly target properties of molecular ensembles.

The relevant areas of competence at the **Institute of Chemistry/Organic Chemistry** at JKU comprise biomolecular structural analysis and specific knowledge on intermolecular interactions. Over the last years the research focus was consistently developed in the area of biomolecular nuclear magnetic resonance (NMR). In addition, for three years protein mass spectrometry (MS) has been developing locally as an important research area (see also below). The pertinent research projects conducted there, address highly specific scientific questions in cooperations with international networks. Central topics are intermolecular interactions, electron transfer proteins and photoreceptors.

The scientific instrumentation of these institutes in the fields of NMR and MS is relatively up-to-date. At the *Institute of Chemistry* Austria's first and only NMR-cryo-probe has recently been put into operation and the local MS research team is the only group in Austria which studies protein folding by ESI mass spectrometry.

In the past three years over 1.3 Mio Euro has been acquired from external sources.

It should also be noted that both NMR and MS are both fundamental and at the front line in current international main stream research. Their importance is underscored by the 2002 Nobel award in chemistry going to researchers in those fields.

In the **Analytical Chemistry department** the main expertise is in the quantification and structural analysis of biomolecules using chromatographic and electrophoretic techniques in combination with MS. For this purpose a quadrupole MS with electrospray source, a time-of-flight mass spectrometer with electrospray and nanospray sources as well as several liquid chromatography and capillary electrophoresis instruments which can be connected to MS are available.

So far new separation techniques for amino acids and peptides based on capillary electrophoresis with mass spectrometric detection have been developed. The experience in chromatographic micro- and capillary column technologies is of increasing importance in proteomics research. Together with the organic chemistry group, time-of-flight mass spectrometry is used to elucidate structures of proteins and their complexes.

These resources shall become a pivotal building block in the *Strong Point Initiative BIOSA* for structural analysis of biomolecules of different origins. The analytical chemistry group has historically been focused on organic analytical chemistry. A shift of focus to biomolecular topics would be also in accordance with strategical development plans of the *Strong Point Center (Exzellenzschwerpunkt) Chemical Design*.

Although the excellent potential of the Biomedical Research at the University of Linz is clearly evident from the evaluation presented above, a *joint initiative focusing and linking* the existing activities and methodologies will substantially enhance the qualitative and quantitative output both in basic and applied biomedical science and technology.

These ambitious aims will be targeted by the *Strong Point Initiative BIOSA* as presented in the following strategic objectives.

### 3. Strategic objectives for the implementation of *BIOSA* at the University of Linz

#### 3. 1.

**Research focus**  
Information Transfer in  
Biological Systems

The *Strong Point Initiative BioSystem Analysis (BIOSA)* will emphasize investigation of “Information Transfer in Biological Systems”. Most of the molecules that carry and process messages inside a living cell are associated with compact clusters of these signaling molecules that are attached to cell membranes or the cytoskeleton. These clusters, variously termed signaling complexes, signal cassettes, signaling modules, signalosomes, or transducisomes, operate as functional processing units. Each receives one or more input signals and generates one or more specific output signals. Signaling complexes are important conceptually because they provide an intermediate level of organization analogous to the integrated circuits used in the construction of large electronic circuits. Cell signaling operates through an intricate network of biochemical and electrochemical pathways, whose complex functioning is insufficiently understood.

**Objectives-Research**  
To explore and exploit  
information transfer units

The general motivation of our research goals is to disentangle the complex network of molecular interactions that characterizes even the simplest forms of cellular communication into functional units processing information transfer. These units transfer information in general via a *conformational, electrical or/and photonic* signal. Within such an unit we aim at resolving the spatial and temporal dynamics of signaling molecules to understand their interactions governing the unit’s function. This function for instance will then be used for applications such as biosensors.

**Characterization of transfer units**

To understand cellular information processing requires the simultaneous application of many capabilities by multidisciplinary teams of scientists. Our intent here within *BIOSA* is to advance molecular science well beyond the current state of the art. To accomplish this task, the groups and methodologies located at the university of Linz will be focused by the *Strong Point Initiative BIOSA* promoting combination of technologies and new approaches. The research projects that will be targeted in *BIOSA* will originate from current

activities of the various groups or initiated from the numerous national and international collaborations, particularly with cell biology groups. The GENAU project where several research groups of the University of Linz already cooperate, will provide a kind of starting point with the T-lymphocyte, an important component of the immune system. In this cell type information transfer units that transmit both *Conformational and Electrical Signals* are interconnected. Analysis of their function based on protein translocations and protein-protein interactions will be key to understand and later on manipulate T-cell activities. Single molecule fluorescence microscopy, calcium imaging and electrophysiology are methodologies that currently already focus on this cell type. The other techniques available in *BIO SA* can efficiently complement the approaches established so far.

Key to this work is taking an integrative perspective of the whole cell and describing the system in terms of measurable parameters for the information transfer units. These parameters will be aspects of e.g. protein-protein interactions, analysed using biochemistry, mass spectroscopy, NMR, molecular recognition force microscopy, fluorescence microscopy imaging and functional assays such as electrophysiology.

In the following the *key researchers* give a brief outline of their approach to the analysis of the information transfer units.

#### Identification

**Mass Spectrometry** (*W. Buchberger, R. Grandori*): Mass Spectrometry (MS) has emerged as a sensitive technique for the investigation of non-covalent complexes. The interactions between proteins, proteins and nucleic acids, or proteins and cofactors can be studied by MS, deriving complementary information to that provided by other biophysical methods. As analytical tool, MS enables identification of biological compounds in non-covalent complexes that have been isolated from cells using efficient tags for purification. Extending the current MS in Linz by an ion-trap and a MALDI system will allow to identify partners of protein-protein interactions, or proteins with an expression profile of interest. The main goals of these studies are to characterize the nature of the intermolecular interactions in complexes and to understand the structural basis of the specificity of these interactions. Establishment of **yeast and mammalian Two Hybrid Systems** (C. Romanin) provide an alternative and complementary approach to identify protein-protein interactions in information transfer units.

#### Quantification

**Analytical separation techniques** (W. Buchberger) and **Surface Plasmon Resonance** (H. Gruber). Bioanalytical techniques such as HPLC and capillary electrophoresis, in conjunction with MS, will allow to quantify components that interact in information transfer units. These interactions will be further

characterized by a Surface Plasmon Resonance (Biacore) system to resolve kinetics and association constants.

Structure and dynamics

**Nuclear Magnetic Resonance** (N. Müller): Nuclear magnetic resonance (NMR) is the method of choice for investigating biomolecular structure, interactions and dynamics at atomic resolution, thus representing the natural complement to single molecule approaches. NMR-methodology, while experimentally more demanding, also gives unique information on molecular structure in more detail than MS, enabling the localization of interaction sites within a molecular structure at atomic resolution. NMR enables characterization of intermolecular recognition sites and structural studies of membrane constituents in a native or native-like environment. Long term development goals also comprise application of nuclear magnetic resonance techniques to surface layers at interfaces. This field will greatly profit from the combined knowledge pool of the participating research groups.

While NMR of biological systems in solution state can be considered a key technology in post-genomic science, the current front line of biomolecular NMR research and development is mostly in the field of spatially oriented systems. The dual approach will give access to structure and dynamics of information transfer units in biological membranes at atomic resolution. Therefore, ideally the development of NMR research capabilities will follow two major directions: (1) establishing solid state NMR as a standard method of research which requires installation of a solid state as a local research tool and (2) upgrading of the current infrastructure for liquid state NMR to the state of the art. Given the infra-structure environment at a realistic view of the resources available, a non-pumped high field high resolution NMR instrument will be required. As the target problem area will certainly require use of higher field NMR, it seems more economic to access such resources, e.g. via European large scale facilities. Appropriate instrumentation on location, as described above is however a prerequisite for efficient use of the top level research facilities.

Localisation and dynamics

**Fluorescence microscopy** (G. Schütz) employing sophisticated optical instruments can follow single molecules in living cells. The spatial and temporal localization of molecules can be resolved and analysed in life cells, particularly in context with their biochemical microenvironment.

**Confocal fluorescence resonance energy transfer** (C. Romanin) measurements enable to localize and monitor protein-protein interactions and will allow us to test complex models of cell signaling in living cells. **Image analysis algorithms** (E.P. Klement) will be developed to

gain quantifiable information on specific protein expression levels and specific localization/co-localization of interacting components.

#### Localisation and dynamics

**Molecular Recognition Force Microscopy** (MRFM; P. Hinterdorfer) is a technique for studying receptor/ligand interaction on the single molecule level. By measuring interaction forces, insight into the dynamics of the recognition process and a detailed picture of the energy landscape is provided. In addition, we will use the high resolution imaging capability of the atomic force microscope as a tool for studying recognition processes on cell membranes with nm-range lateral resolution. A collaborative project between the *Institutes for Biophysics* and *Electrical Measurement Technologies* (Zagar), and the company *Molecular Imaging* (Tempe, AZ, USA) has been recently installed for the development of improved and customer-usable recognition microscopy modes. Novel algorithms for signal detection and controlling based on digital platforms will be implemented into existing microscopes. A combination of MRFM with single molecule fluorescence microscopy is considered for the future.

#### Function

**Electrophysiology** (C. Romanin): Ion channels that play an important role in signaling processes are monitored both at the whole-cell and single channel level. Current recordings will be related to or directly combined with ion-sensitive fluorescence signals (e.g. Fura-2 for  $\text{Ca}_i^{2+}$  imaging). Moreover, development of devices combining current detection with fluorescence microscopy to monitor interacting components in a life cell by Fluorescence Resonance Energy Transfer will be a future challenge within the context of *BIO SA*.

#### Simulation and data analysis

**Bioinformatics** (N.N.): Information collected from protein interaction sources (both experimental and literature-based) will also yield information about functional units in biological communication pathways, but from a physical-association perspective. Evidence from the various kinds of protein-protein interaction experiments will suggest the outlines of protein-binding cascades within and between the functional units for biological communication. Additionally, structural features of the interactions will be simulated based on structure data bases.

**Theoretical Physics on Soft Matter** (U. Titulaer, N.N.): The present activities in the field of Biophysics concentrate on developing mesoscopic models for the interaction between biomolecules. It is planned to dedicate one of the professorships (in 6-8 years) to the statistical physics of soft condensed matter. This area includes the physics of biologically relevant structures such as membranes and vesicles. The central theme in the physics of soft

condensed matter, the interplay between structure and dynamics on different space and time scales, is also a central one in the *BIO-SA* project, and fruitful synergies are to be expected.



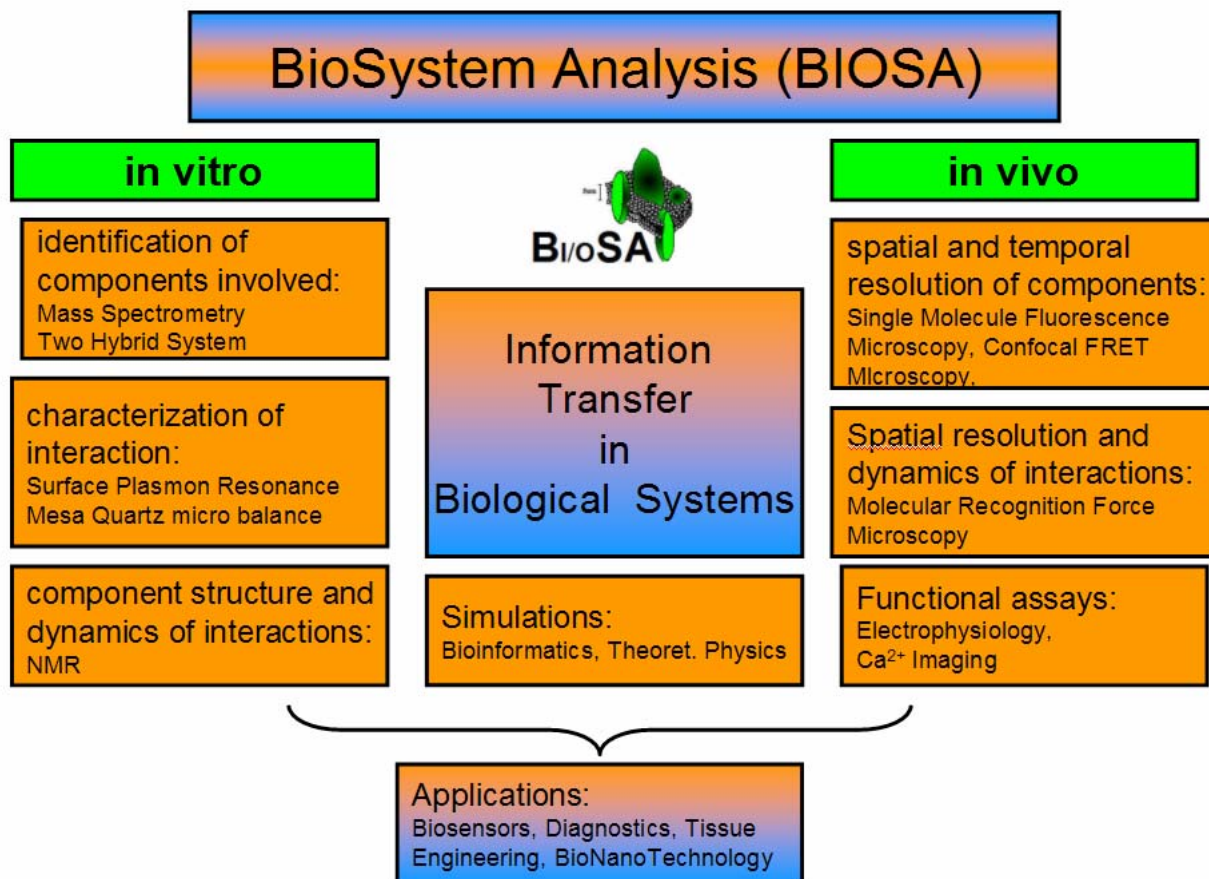
**Biosensors/ BioNanotechnology** (S. Bauer, H. Gruber):

The knowledge obtained from analysis of such information transfer units utilized in and interconnected for biological communication will enable development of further *applications* ranging from diagnostic tools, biosensors, tissue engineering and bionanotechnology.

An important trend in biosensing and bionanotechnology is the development of label-free detection principles for the study of biospecific interactions between components in biological communication. Label-free detection techniques established here in Linz to study biospecific interactions are based on Molecular Recognition Force Microscopy (MRFM, see above) and Surface Plasmon Resonance (SPR). SPR is used to monitor the kinetics of association and dissociation at high and intermediate affinities, whereas weak affinities are difficult to detect. In addition to these techniques, inverted Mesa Quartz or GaPO<sub>4</sub> micro balance (QCM) techniques will be developed as a novel label-free system to detect interaction of biomolecules. In MRFM, SPR and QCM the same unique surface chemistry can be applied, where cell membrane is imitated by covalently bound phospholipid molecules on gold surfaces. These systems will provide a basis for the development of diagnostic sensors (e.g. viral diagnostic sensors, single point mutation detection, etc.).

**Tissue Engineering** (J. Heitz, D. Bäuerle, C. Romanin) is a developing field for cell transfer and cultivation in reconstructive medicine. It is based on the use of biomaterial composites consisting of living cells on a polymer support. The properties of these cells may be adjusted according to the biological requirements by utilizing information transfer units.

The following scheme depicts the connection between the various methodologies applied for the analysis of information transfer units in biological systems targeted within the context of *BIO SA*.



## 3.2.

### Objectives-Teaching

#### 3.2.1. Existing studies programs

a) The Johannes Kepler University Linz is the only university in Austria offering a diploma program in Biophysics as a branch (Studienzweig) of the Technical Physics program. The *BIOISA* initiative would strengthen and enrich this program, in particular by allowing for more electives and thesis projects in the area of biotechnology.

b) Students in the regular Technical Physics, Technical Chemistry and WiTech (a programme combining technical chemistry and business courses) programs spend the last one to two years on a diploma thesis, where they treat a problem from research or industrial development, and on specialized courses introducing them to the area of the thesis. *BIOISA* would increase the opportunities to choose an area of specialization in fields related to biotechnology.

c) One of the areas of specialisation (Studienschwerpunkte) in Technical Physics, designed to be interdisciplinary and to transcend the borders between the traditional sub-disciplines of physics, is "Nanoscience and -technology". Bionanotechnology is an integral part of this program.

#### 3.2.2. Programs in the trial or planning stage

a) A Bachelor-Master program in **Molecular Biology** was conceived as a collaborative project of Universities of Salzburg and Linz, with Salzburg offering the biology part and Linz most of the physics and chemistry part.

This program is currently in the pilot phase with ~15 students attending to it as an "individuelles Diplomstudium".

b) A Master program in **Bioinformatics** building on a Bachelor of Science in Mathematics, Informatics or Physics is planned by the Faculty, and will presumably be started in the next few years.

#### 3.3.3. Longer range perspectives

The existing programs in Biophysics and Nanoscience and -technology may develop into Master of Science programs within the area of Technical Physics. This will help to attract students from other Austrian universities and from abroad (a trend already seen in the Biophysics sub-program.) A similar effect is to be expected from the Bioinformatics program.

#### 3.3.4. Postgraduate Education

In this areas, concentrated courses on the use of techniques of relevance for the analysis of biological systems are already offered in the form of summer schools (NMR summer school) and of a sequel to the annual Linz Winter Workshops organized by the Institute for Biophysics. They are well attended by researchers from industry and from other universities. As new techniques are introduced, the spectrum of such courses should be extended as well. Whether these offerings should be extended to a formal postgraduate course or courses will depend on discussions to be held in particular with interested companies, and on the development of the biotechnology industry in Upper Austria and in neighboring areas.

In the ways specified above the *BIOSA* initiative will increase and improve the supply of much needed specialists for the developing biotechnology sector, improve the attractiveness of the University of Linz for good students, and will provide support for a developing industrial sector. The implementation of *BIOSA* will be accompanied by Molecular Biology (both Bachelor and Master of Science), Bioinformatics (Master of Science) and the Universitätslehrgang Bio-Technologies.

### 3.3.

#### **Objectives-Organization**

To develop the *Strong Point Initiative BIOSA* a steering committee will be established consisting of the group leaders, two scientific advisors and two representatives of the Austrian industry. Among the group leaders, a coordinator and speaker of *BIOSA* as well as a vice-coordinator will be elected for a period of 2 years. The two scientific advisors have been already nominated, Prof. S. Petersen, Institute of Life Science, University of Aalborg, Danmark and Prof. H. Oberleithner, Department of Physiology, University of Münster, Germany, and their suggestions have been already included in the concept of the *Strong Point*

*Initiative BIOSA.* Both have agreed to advise this initiative over the next 5 years. As representatives of the Industry, one position will be preferentially held by Prof. M.W. Müller, VBC Genomics Vienna, the second has still to be nominated.

### 3.4.

#### **Objectives-Personnel**

While the experimental groups coming mainly from basic science are established, the *BIOSA* initiative requires on the one hand an extension onto groups with more **theoretical background**, and on the other hand groups strengthening the **applied bioscience**. Thus, the following competences should be established at the University of Linz.

A professorship in the field of **Bioinformatics** preferable of Structural Bioinformatics (This position will be soon advertised)

A professorship in the field of **Theoretical Physics preferable on Soft Matter Physics**. It is planned to dedicate one of the professorships (in 6-8 years) in the Institute of Theoretical Physics to the statistical physics of soft matter.

A professorship in the field of **Bioorganic Chemistry or Technology**. Such a position is planned within the *Strong Point Center Chemical Design* and would contribute to the development of “functional molecules” for e.g. diagnostics assays.

A professorship in the field of **BioNanoTechnology**. This position will be shared among the *Strong Point Center Nanotechnology and Nanoscience* and *BIOSA*, and will be dedicated to promote applications emanating from both fields, e.g. tissue engineering.

A pool of **8 post-doc positions** would be required to particularly catalyse the cross-linking between the various groups contributing to *BIOSA*. In the first year 4 post-docs should start. These post-docs will be in charge of handling the equipments as well as supporting their optimal use.

### 3.5.

#### **Objectives-Investments**

Investments on *personnel costs* will cover one ½ secretary position supporting the coordinator of *BIOSA* and 8 post-docs. The tenure-track position would be desirable for continuous support and servicing of the solid-state NMR.

Investments on *teaching activities* have been already calculated for the Bachelor-Master Program **Molecular Biology** comprising €40.000.- per year.

Investments on the *technical equipment* are required to keep the experimental systems up-to-date and applicable for the research as well as the teachings targeted in *BIOISA*, and to renew basic infrastructure.

### Investments

<i>Personell</i>	<i>costs per year (€)</i>
Secretary ½	13.625.-
1 tenure-track position	44.875.-
8 post-docs for a maximum of 5 years (a 45.720)	365.760.-
<i>Teaching activities</i>	
Molecular Biology Program	40.000.-
<b>TOTAL</b>	<b>€464.260.- per year</b>

<i>Equipment</i>	<i>costs per 5 years (€)</i>
Mass spectrometry (Maldi, Ion-Trap)	450.000.-
High-field liquids-NMR	2.200.000.-
Solid state NMR	1.400.000.-
Up-Grading of Systems (Fluorescence Microscopy, MRFM, Electrophysiology, impedance and spectrum analyser)	600.000.-
Basic infrastructure renewal	350.000.-
<b>TOTAL</b>	<b>€5.000.000.- per 5 years</b>

Both solids- and high field liquids-NMR-instrumentation which require the highest investments will also provide substantial benefits for other research efforts located at the university of Linz, in particular in the Strong Point Centers "*Chemical Design*" and "*Nano-science and -technology*". Moreover, the solid state NMR as the first in Austria should be accessible also to groups of other Austrian universities.-t

### 3.6. Time-table

*Personell*: The secretary should be installed at the beginning of *BIOISA* in 2004, the tenure-track position with the delivery of the solid-state NMR. 4 post-doc positions should

immediately start at 2004 catalysing the establishment of cooperative projects. The remaining 4 post-doc positions should follow in 2005.

*Teaching activities:* The costs have so far only been calculated for the Bachelor-Master program Molecular Biology which should be established as a regular program in 2004.

*Equipment:* The costs for the equipment have been split over the next five years.

Equipment	2004	2005	2006	2007	2008
(k€ per year)	1.116,6	1.116,6	1.1150	883,4	883,4

The financing of *BIO-SA* should be achieved by funding from the university of Linz and external funding. The university part should comprise a part of the *Personnel* costs and the whole costs for *teaching activities*. The *equipment* will be financed mainly by external funding from national and international programs.

### 3.7. Networks

Within the University of Linz, the *Strong Point Initiative BIO-SA* is linked to and has been coordinated with the two other *Strong Point Centers Nanoscience and Nanotechnology*, and **Chemical Design**.

A network comprising the activities on Life Science and Bio-Technologies in the university and extra-university environment of Upper Austria is depicted in the following cartoon.

