Higher Institute of Technologies and Applied Sciences
InSTEC

COMPUTATIONAL TOOLS FOR SIGNAL PROCESSING APPLICATIONS FROM INDUSTRY AND BIOINFORMATICS

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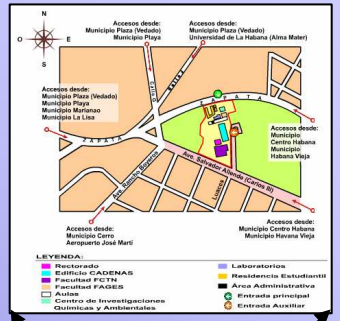
02/2006

Institute Site (Main CAMPUS)



BIOINFO National Bioinformatics Center

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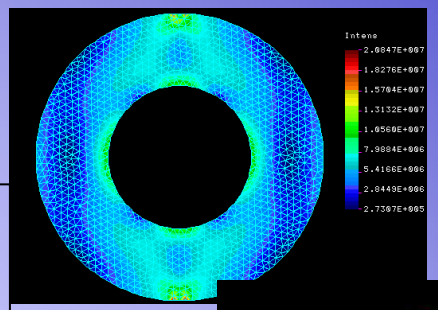
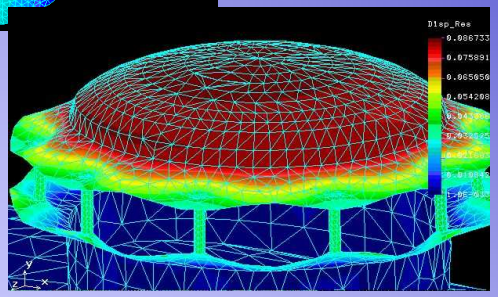
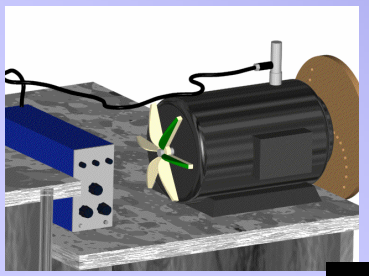
Research fields

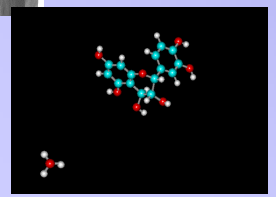
Research fields

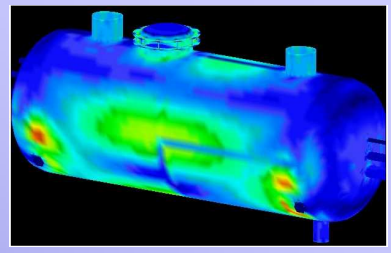
- Signal Processing (MV-SoftWare-Indust.)
- Computational Chemistry
- Photodynamic
- Theoretical and Applied Physics
- Environmental IMPACT, EDUCATION
- Recycling, Composting











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SUMMARY

Indicators description (Nonlinear Dynamic)

Application to mechanical systems. TEP, NPP

Bioinformatic Application (Biological Systems).

Flavonoids/Proteins Interacction

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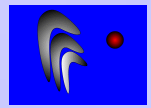
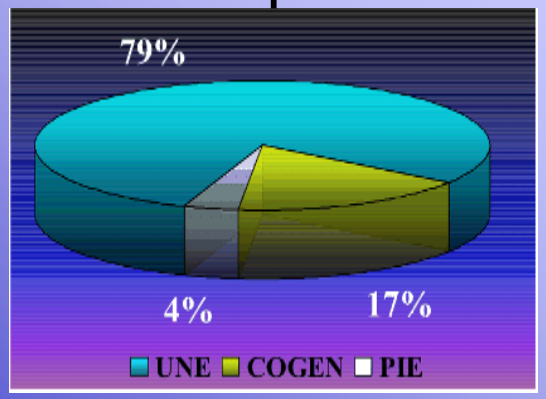


Electricity generation in Cuba. Principal Sources

1959 - 397 MWt → 56% → > 3 000 MWt



TURBINES
Thermal PS

HIGHLY COMPLEX MACHINES

Combination of
THREE MAJOR PARTS

- **ROTOR**
- **FF-BEARINGS**
- **SUPPORTING STR.**

CONDITION MONITORING SYSTEMS

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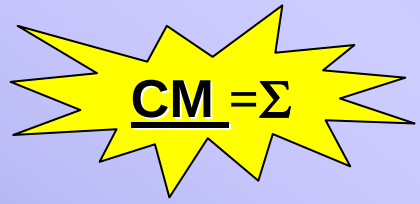

The **trend in the Condition Monitoring** is the combination of different methods.

The principal task of the signal processing is to extract the **maximum** amount of the all significant diagnostic information **from the original signals** generated by the transducers.

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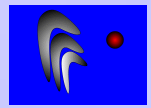
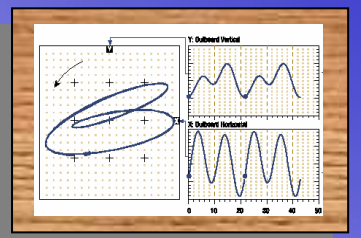


Indicators description (Nonlinear Dynamic)

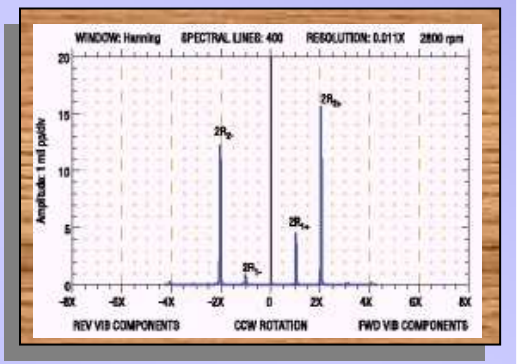
For **CMS** sofisticate systems are monted **ON LINE**:



Procedure → Lineal dynamic → FFT

1.Trend Diagrams
2.Waterfall Diagrams.
3.Start-up and Shut-Down.
4.**Orbit** Representation.
5.Temporal Series
6.Spectral analysis.
7.Multi-Spectral Comparison.
8.Envelope Analysis.
9. “Cepstrum” application.
10.**Full Spectrum**

The evolution of Patterns fron **linear to nonlinear** and the appereance of **combined faults**



.... → the diagnostic information is **not enought**

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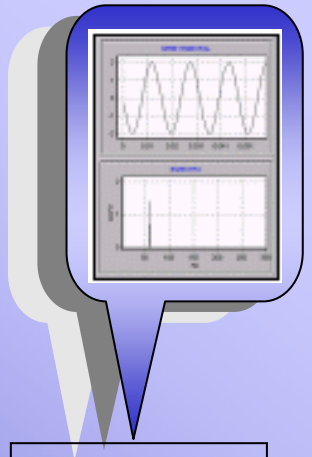
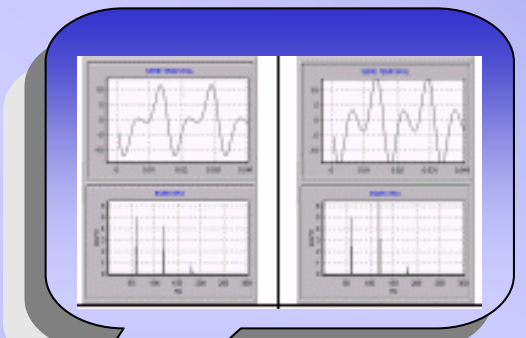
SPECTRAL ANALYSIS...

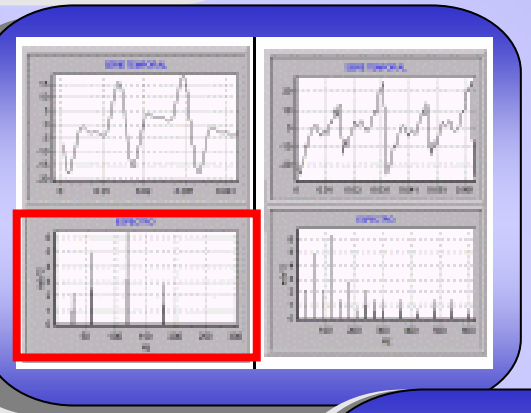
Typical Faults



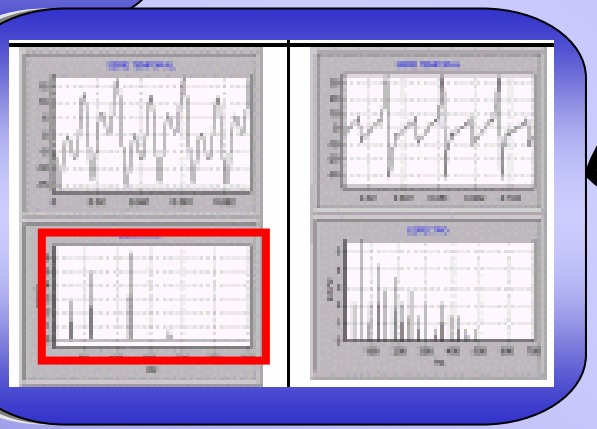
Unbalance



Coupling Misalignment



Loose Stationary Part Malfunction



Fluid induced Instabilities

Time to Frequency: common used for a better understanding of **time series** and for **analysis and fault classification**.

Frequency lines = **defects**, common way to fault detection

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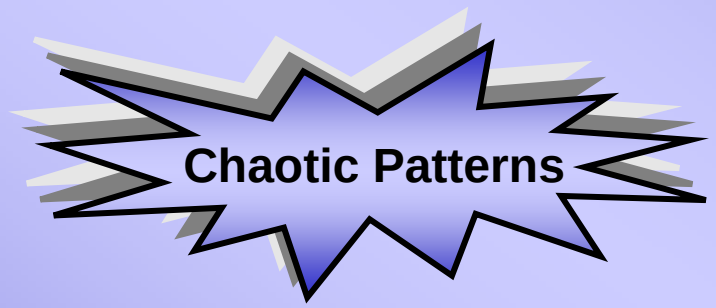
Indicators description (Nonlinear Dynamic)



The **CHAOTIC BEHAVIOR** of rotor to stator system

Interaction between rotating shaft with its stator and supporting structure.

Divergence from the normal Operational Condition

1.- Looseness in the stationary joints;

2.-Oversize, poorly lubricated bearing:

3.-Rubbing rotor:

Physical Phenomena

1.- System Stiffness f(t) increase/decrease

2.- **Impacts.**

3.- **Friction**

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Indicators description (Nonlinear Dynamic)

Correlation Dimension $D_{2.}$ (applied to mechanical systems)

1. –**Estimation** = Dificult task (as a function of analized mechanical system)
2. –Automatic determination. (on line processing)

Pseudo-Phase Portrait **PPP**

1. – Under study.
2. – Limited analysis of the geometrical configuration.

.... → It is necesary to develop **new methodology** and descriptors with **high sensitivity**.

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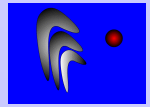
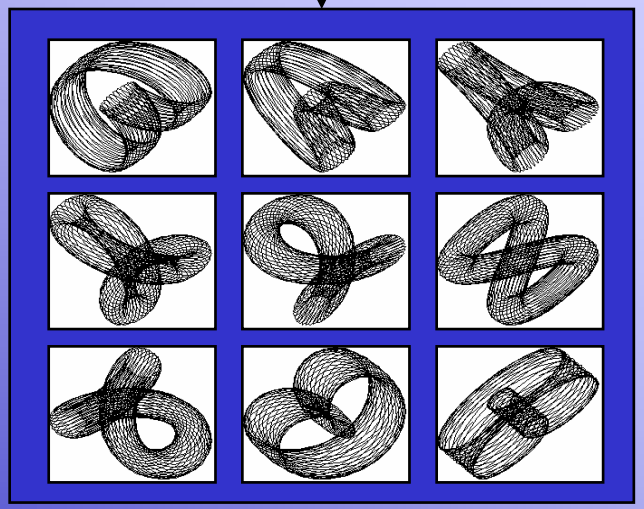


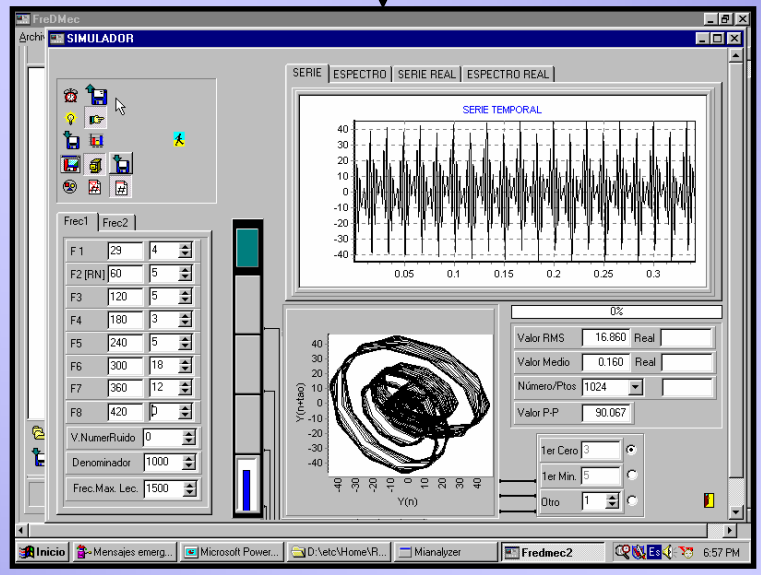
Indicators description (Nonlinear Dynamic)

Method of Delay [**MOD**]

$$X_i = \{ x_i, x_{i+\tau}, \ldots, x_{i+(m-1)\tau} \},$$

First Zero FAC(τ)??





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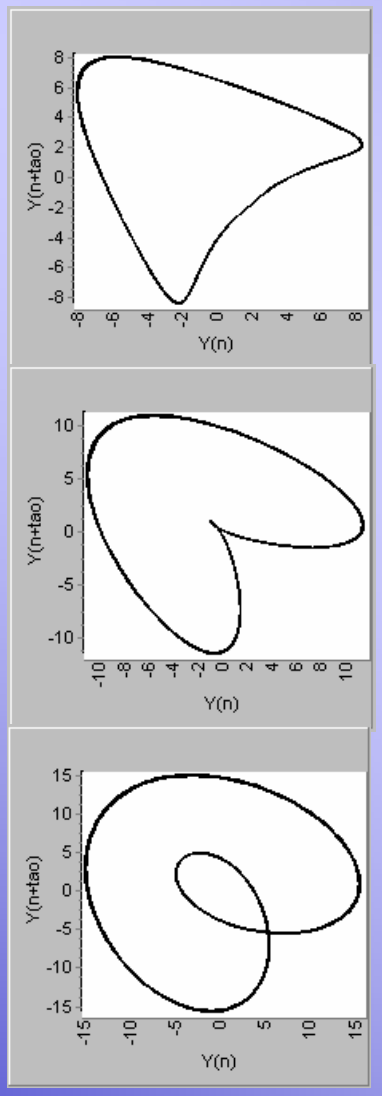
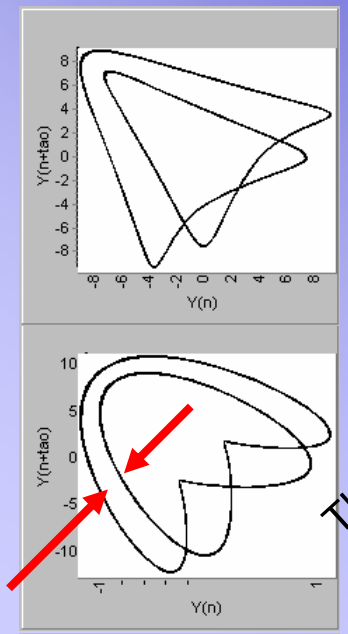
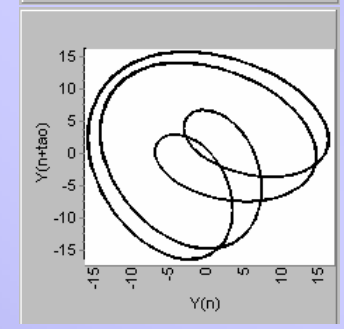
Structural problems

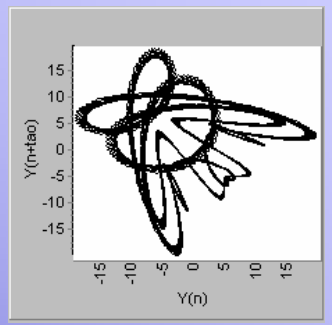
Tipical FAULTS vs 2D-PS

Coupling Misalignment



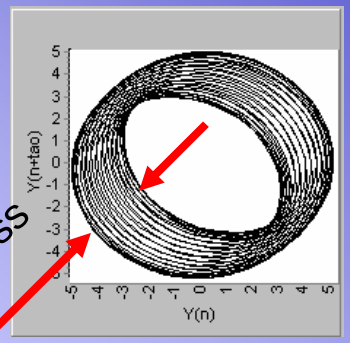


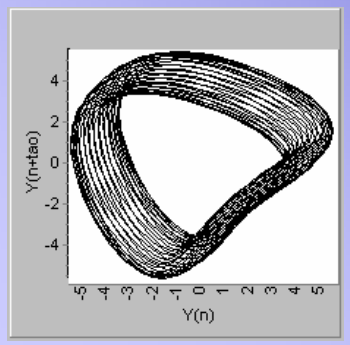


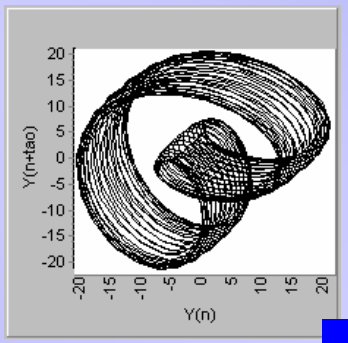


Hydrodynamical faults

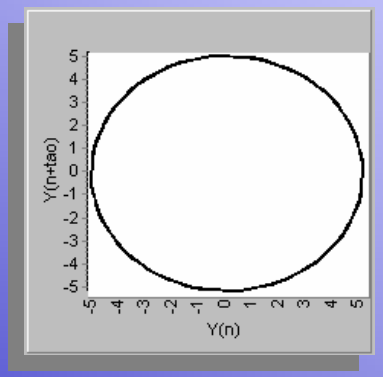
Thickness







Unbalance

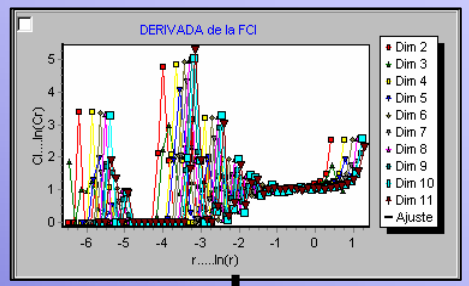


PPP as Patterns

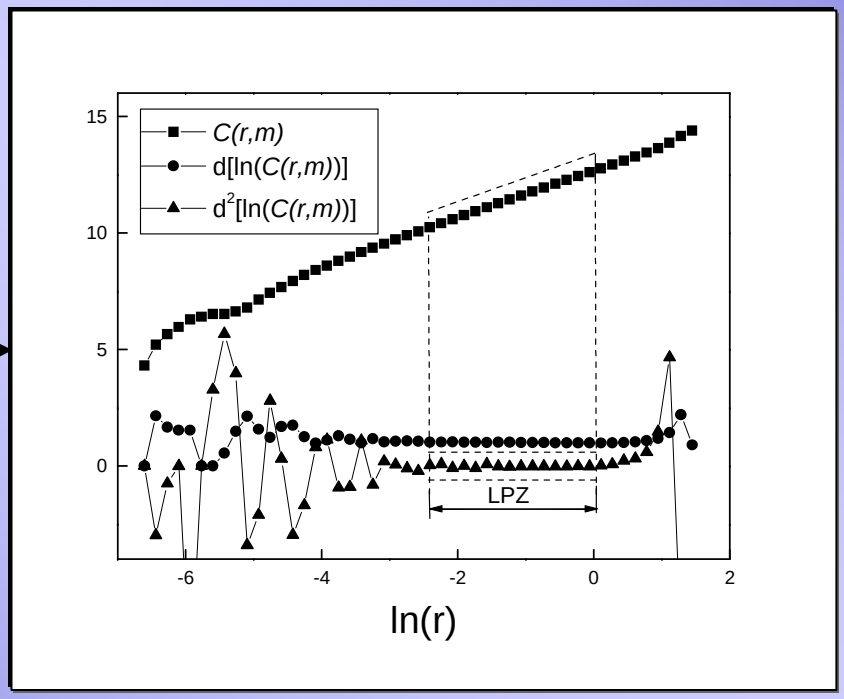
Indicators description (Nonlinear Dynamic)

D_2 = slope of the scaling region $C(r,m)$

$$C(r,m) = \frac{2}{N_m(N_m - 1)} \sum_{\substack{i,j=1 \\ (j>i)}}^{N_m} \Theta\left(r - \left\| x(i,m) - x(j,m) \right\|\right),$$



A-AD-QE Method



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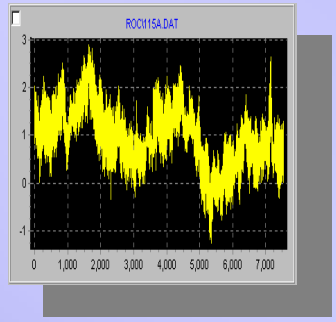
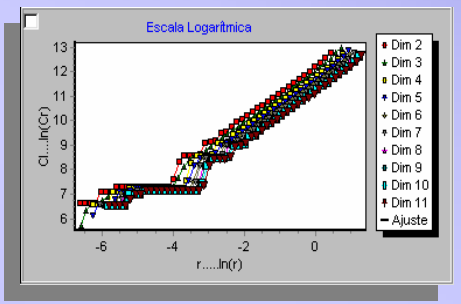
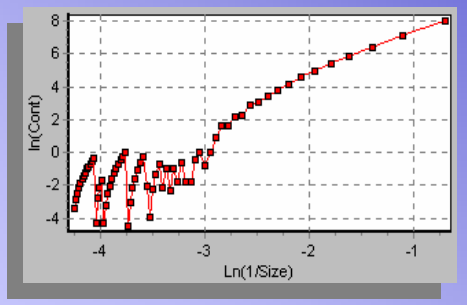
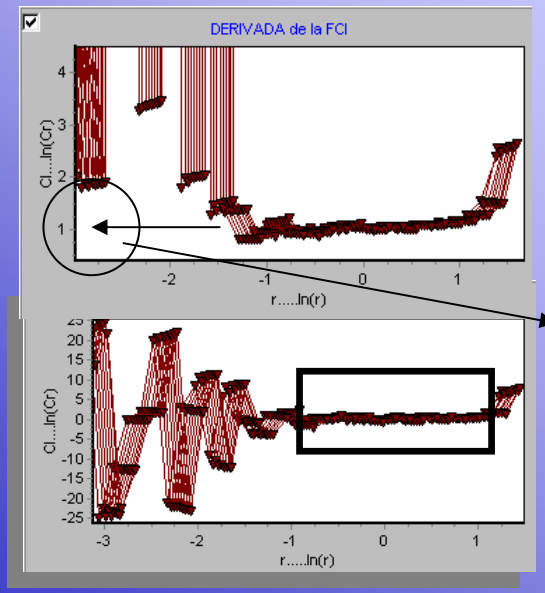
[A-AD-QE] method

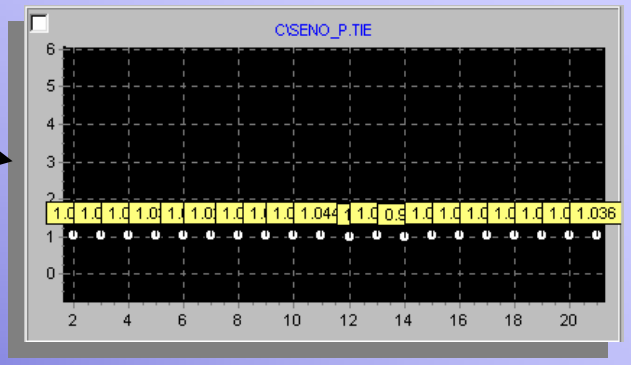


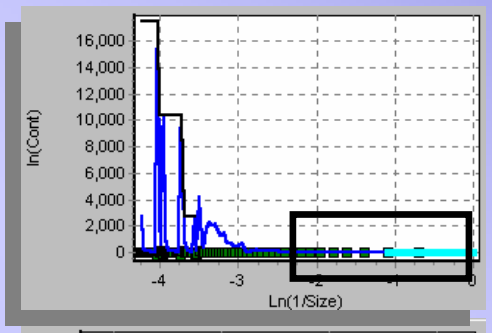


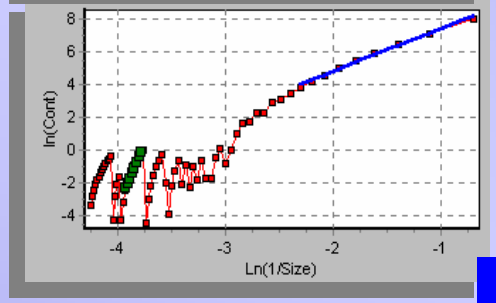


APPLICATIONS









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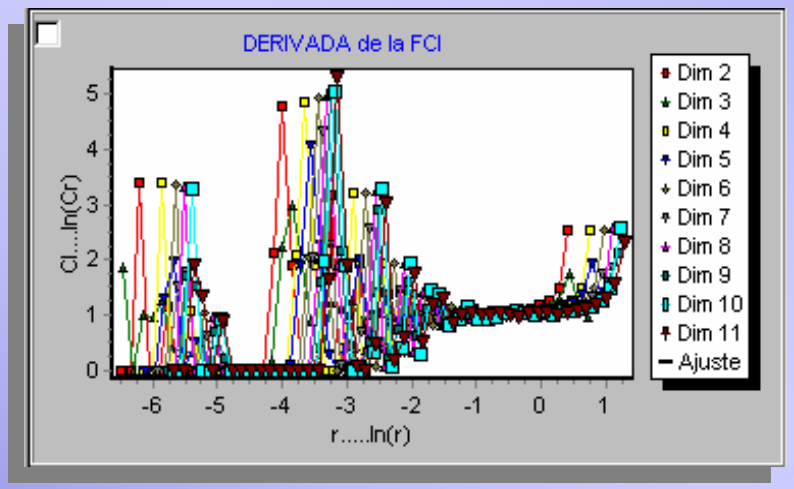
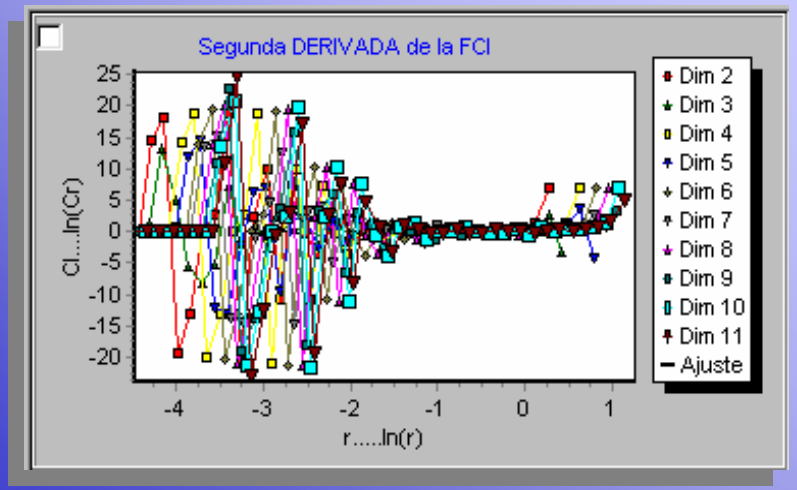
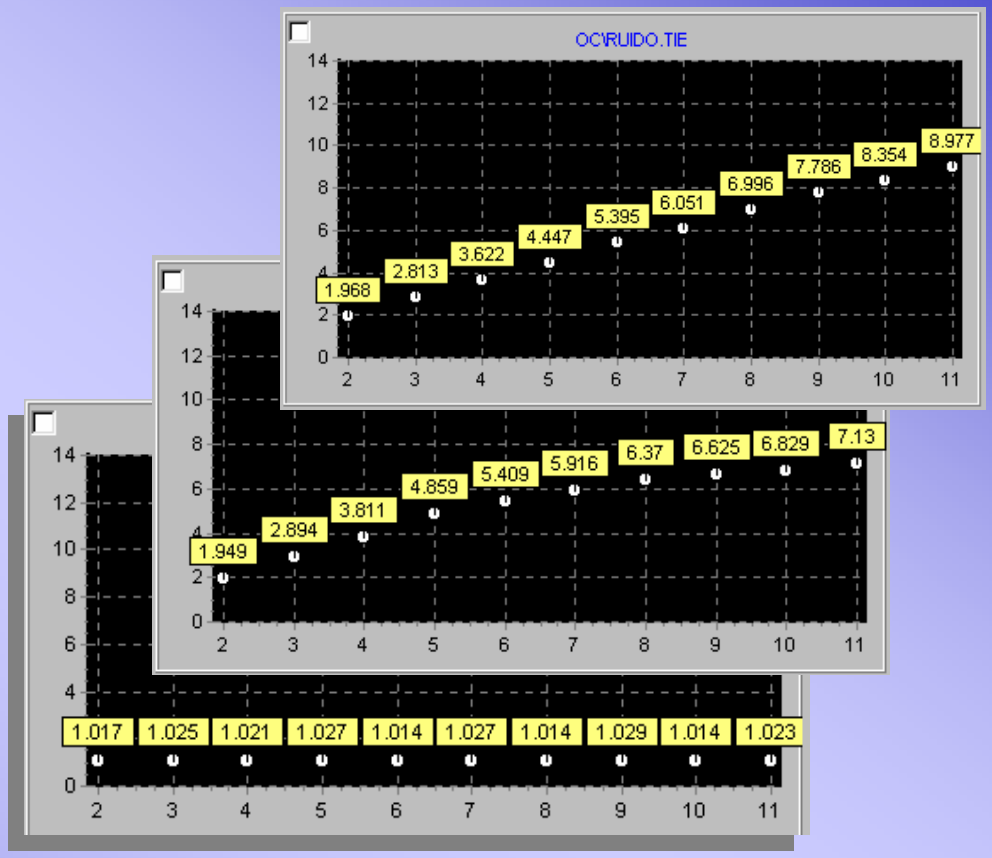
A-AD-QE







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Application to mechanical systems. TEP

THE **PSEUDO-PHASE PORTARIT** AND **FD** APPLIED TO

- Faults identification in **Thermoelectrical PP**
- Power instability in the **N.Reactor**
- Internal Vibration of **N.Reactor**

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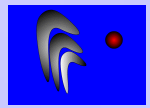
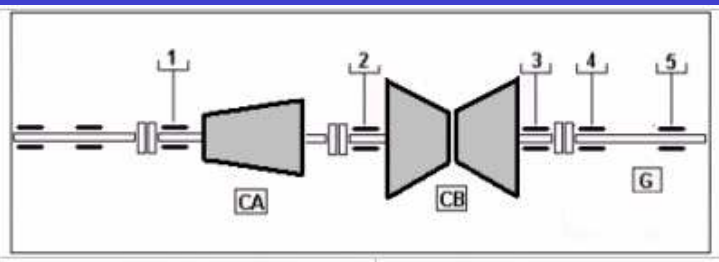


Application to mechanical systems. TEP

Data collection system…



1024 points
500 Hz
1.. 10 Records

Turbine

↓

VibroControl 4000

↓

Charge amplifier: B&K 2626

↓

ADConverter

↓

SoftWare VibraMec

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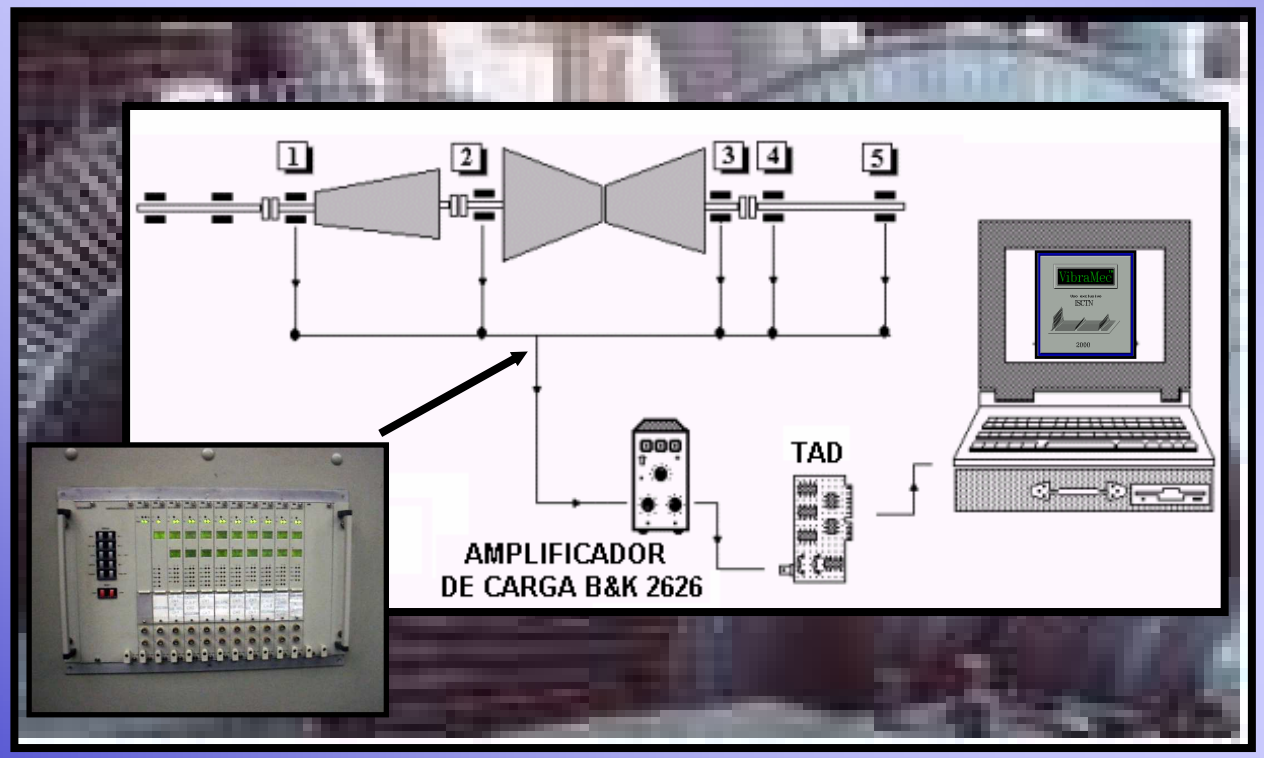
Application to mechanical systems. TEP

Experimental measurements in a Cuban TP



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Application to mechanical systems. TEP

PPP: Indicator of mechanical Changes

Point: '**4V**'.

State:
[13 MWt, 7:32 - 7:38 pm].

Spectrum evolution :
Similar behavior,
PPP: Show
morphological modifications.

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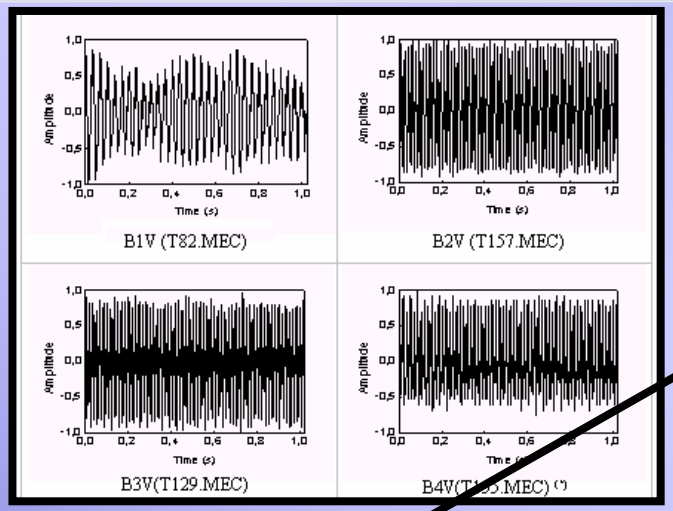
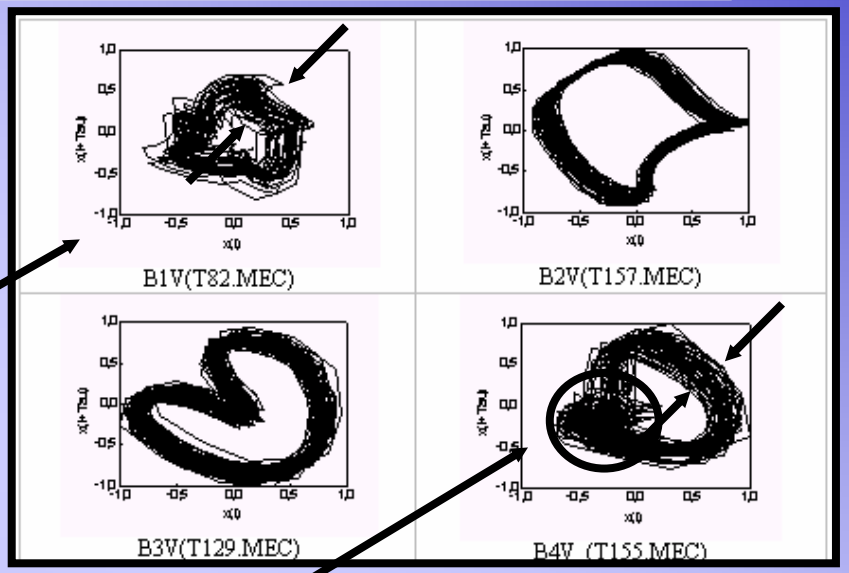
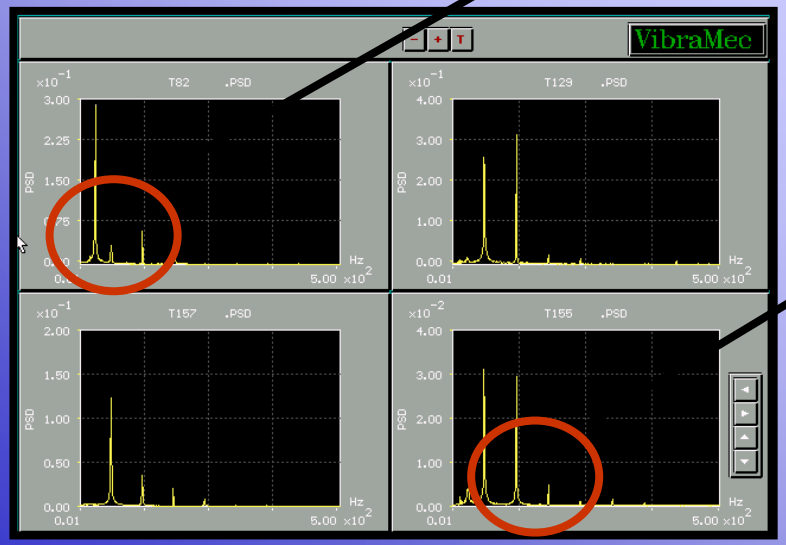
Application to mechanical systems. TEP







LZP calculado Por el método A-AD-QE (*)			$(D_2 \pm \sigma)$
$\ln(r_1/r_0)$	$\ln(r_2/r_0)$	LZP	
1.37	1.07	0.30	**1.86** ± (<0.01)
2.13	1.08	1.05	1.15 ± (<0.01)
1.11	0.59	0.52	1.14 ± (<0.01)
0.99	0.65	0.34	**1.34** ± (<0.01)

PPP and CD

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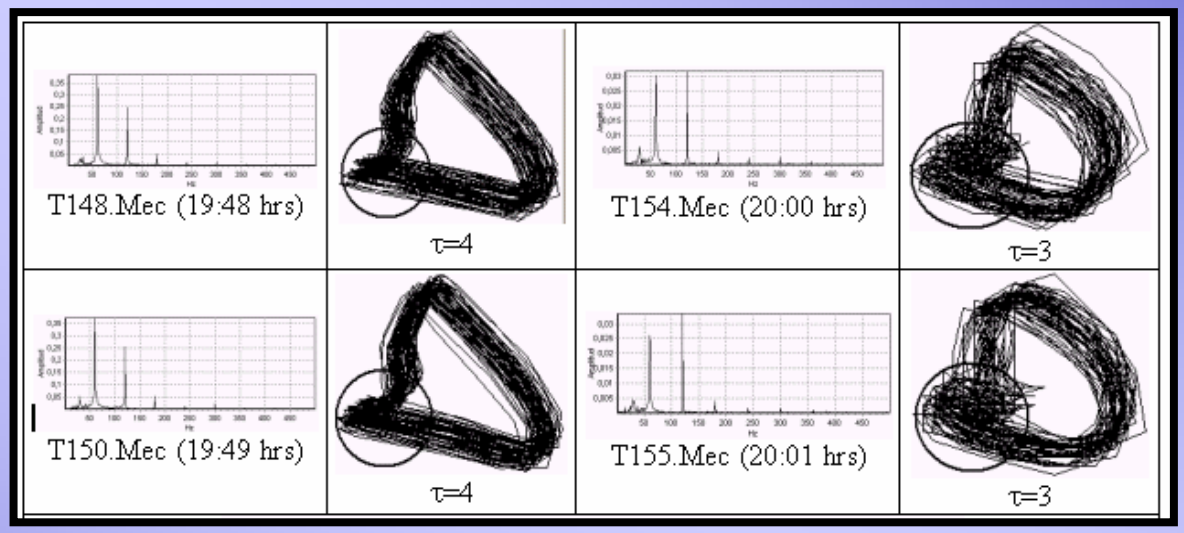
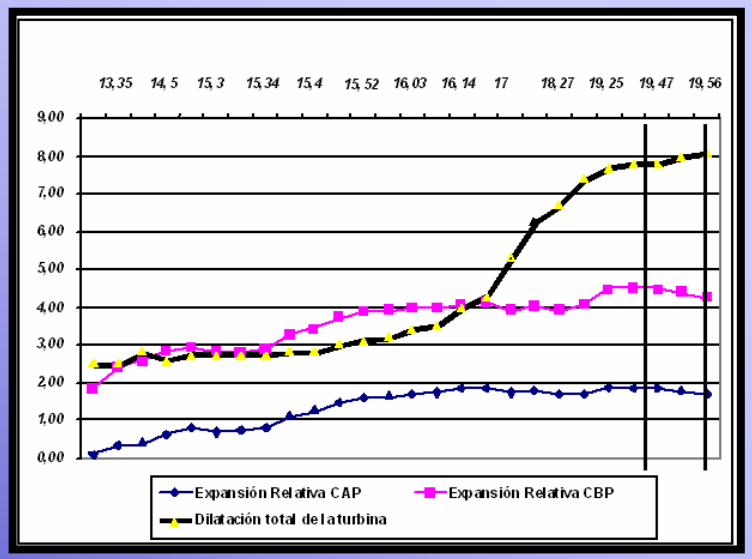
Application to mechanical systems. TEP

PPP vs Total dilatation of a Turbine





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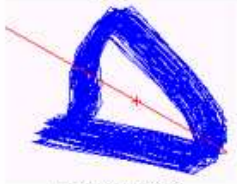
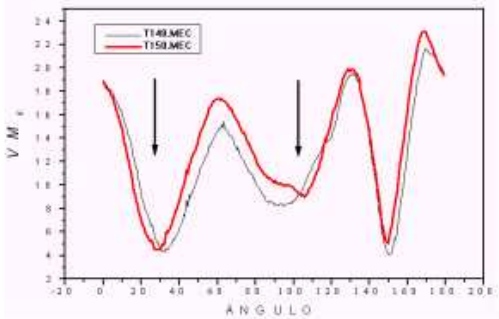
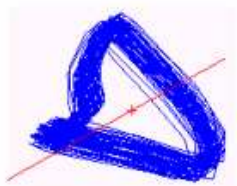
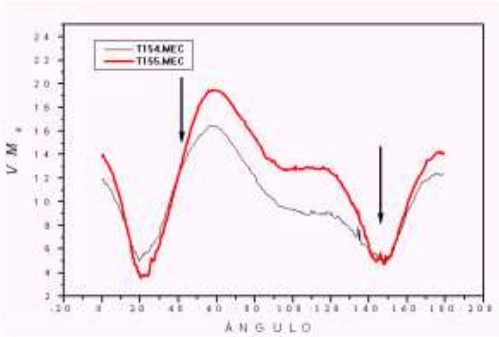
Application to mechanical systems. TEP

PPP vs Geometrical Configuration

Gr.	EFB	AD_L, grad.	VM_k vs ángulo
I	 T148.MEC	150.5	
	 T150.MEC	29.5	
II	 T154.MEC	149.0	
	 T155.MEC	21.0	

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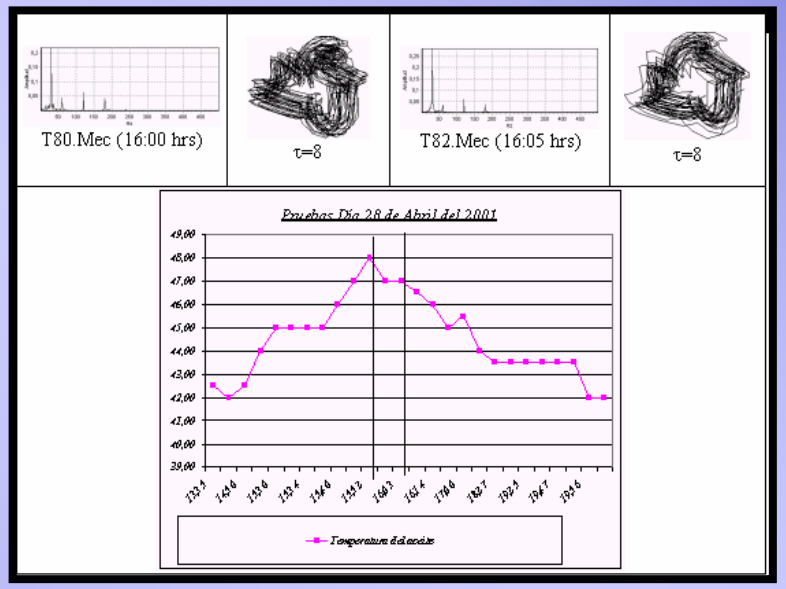
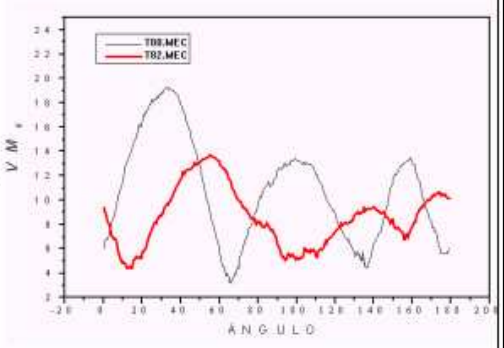
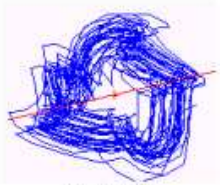
Application to mechanical systems. TEP

PPP vs Oil temperature



EFB	AD_L, grad.	VM_R vs ángulo
 T80.MEC	66.5	
 T82.MEC	13.0	

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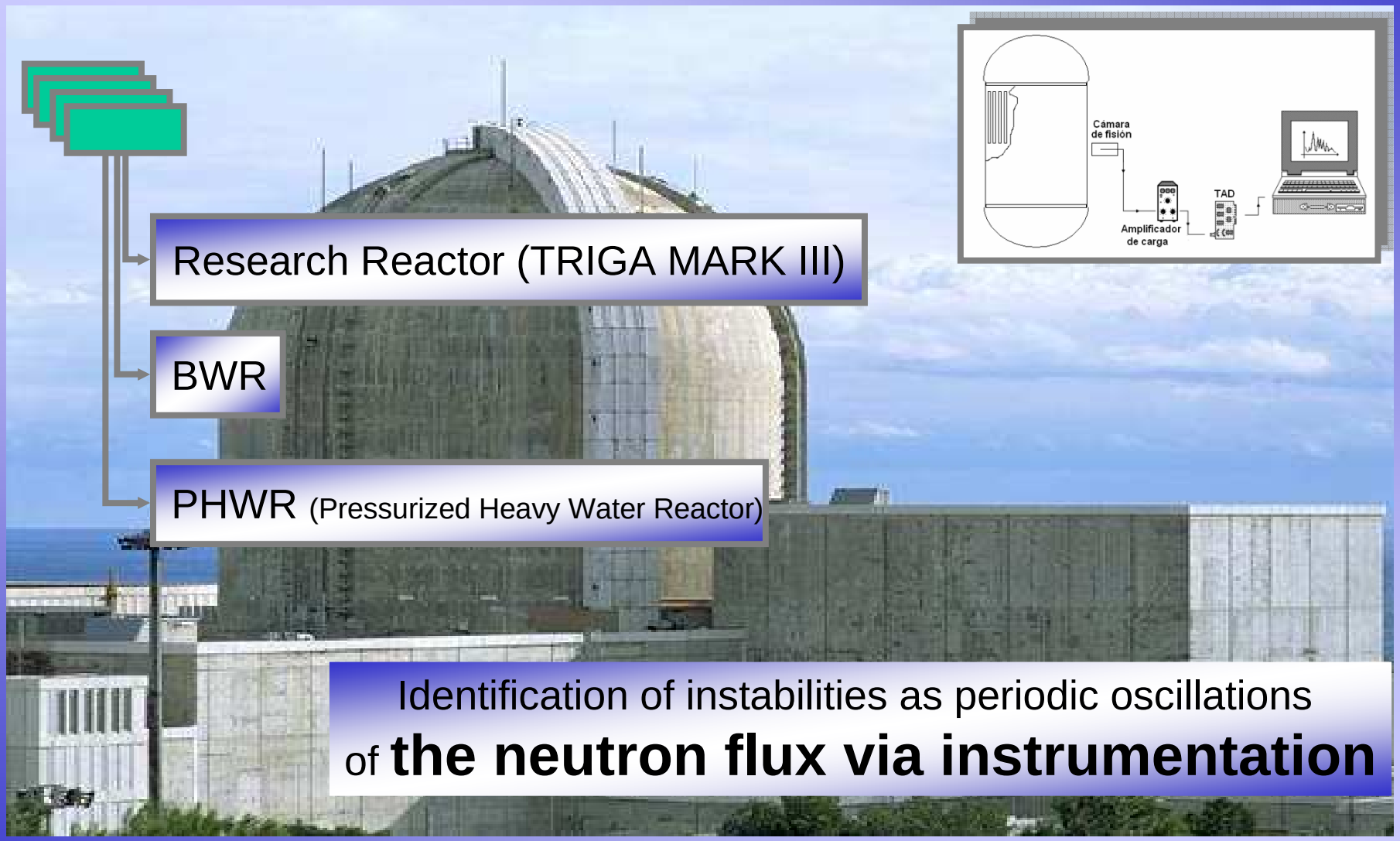
Application to mechanical systems. NPP



- Research Reactor (TRIGA MARK III)
- BWR
- PHWR (Pressurized Heavy Water Reactor)

Identification of instabilities as periodic oscillations of **the neutron flux via instrumentation**

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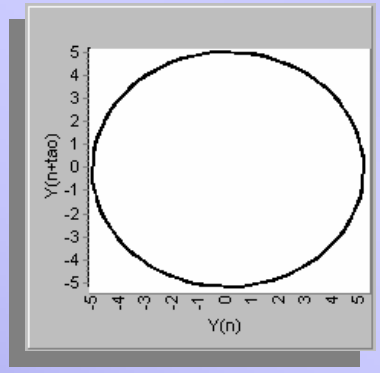
Application to mechanical systems. NPP

Decay ratio (**DR**) or **the main frequency**,
Both indicators are evaluated by means of ARMA (parametrical modeals)

The main **hipotesis** : Lineal behavior of the NUCLEAR REACTOR;
Nevertheless: **nonlinear behavior** ,

Instability case of the Nuclear Reactor



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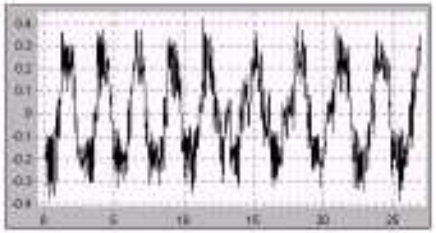
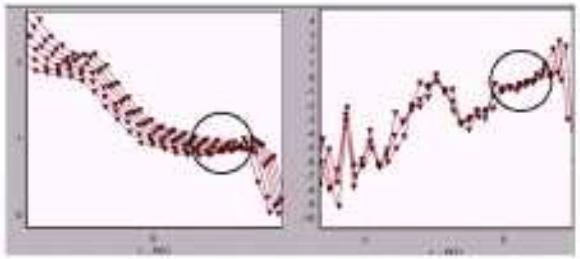
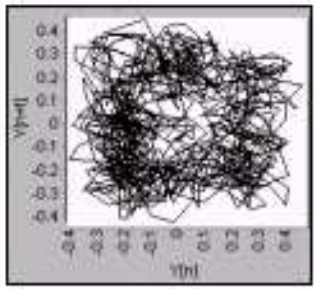
Application to mechanical systems. NPP

Research REACTOR-TRIGA MARK-III

www.cnsns.gob.mx

Tipo de Reactor	Resultado de la aplicación de **A-AD-QE**	**EFB**	**DA**
TRIGA MARK III	 		0.931 ± 0.051

PPP configuration and the CD value

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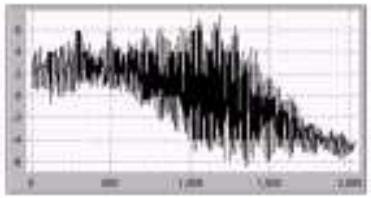
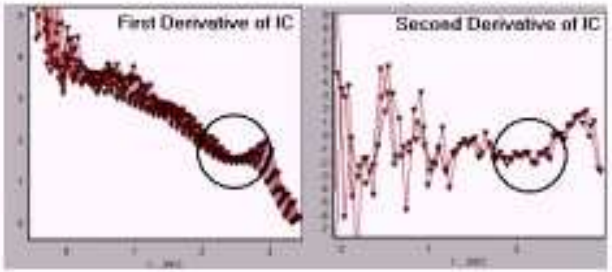
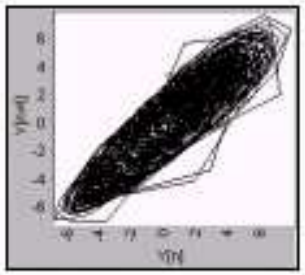
Montesino M.E., **Rolo N.A.**, Azoy C.A. (2003), The attractor dimension determination applied to monitoring and surveillance in Nuclear Power Plants. ***Progress in Nuclear Energy***, Vol. 43, No. 1-4, pp. 389-395.

Application to mechanical systems. NPP

Cofrentes-Spain

www.csn.es

Tipo de Reactor	Resultado de la aplicación de **A-AD-QE**	**EFB**	**DA**
BWR/6	 		1.6455 ± 0.003

Limit Cycle corrupted by NOISE

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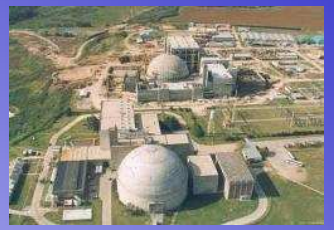
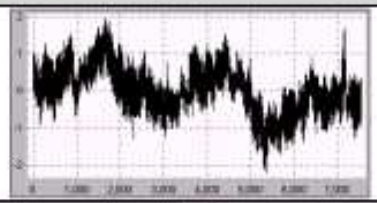
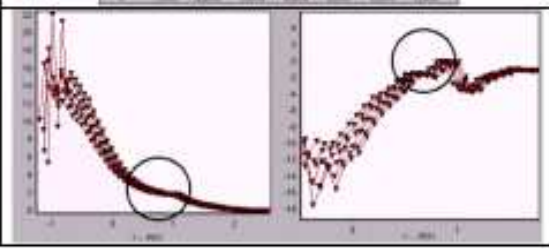
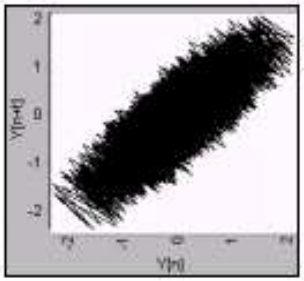
Montesino M.E., **Rolo N.A.**, Azoy C.A. (2003), The attractor dimension determination applied to monitoring and surveillance in Nuclear Power Plants. ***Progress in Nuclear Energy***, Vol. 43, No. 1-4, pp. 389-395.

Application to mechanical systems. NPP

Atucha I-Argentina



www.cnea.gov.ar

Tipo de Reactor	Resultado de la aplicación de **A-AD-QE**	**EFB**	**DA**
PHWR	 		2.417 ± 0.105

Complex dynamic behavior
Internal Vibration of the Reactor

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Application to biological systems

The **Pseudo-Phase Portarit and Fractal Dimension**

applied to pattern recognition in biological systems.

its approach to FLAVONOIDS-PROTEINS INTERACTION

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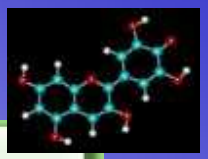
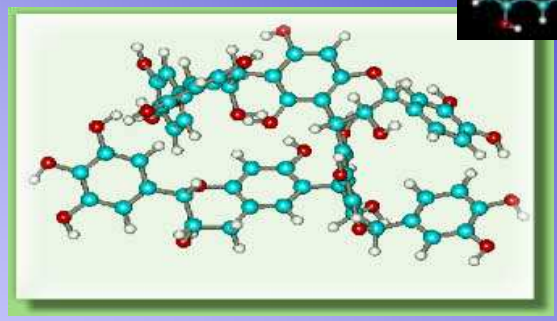
Application to biological systems

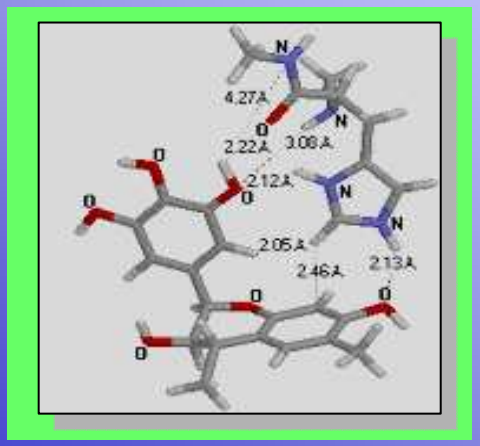
Flavonoids



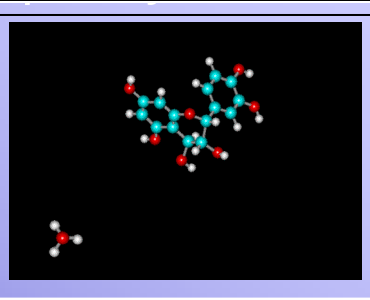


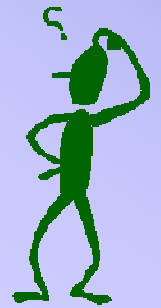
class of polyphenolic compounds found in several plant species and in plant related foods (red wine, tee, olive oils, vegetables, fruits, nuts).

These compounds have evidenced very good health effects during years and **their interaction with proteins seems to be one of the most important causes of their bioactivity.**



We do not have general patterns for the characterization of **Flavonoids-Proteins Interactions**, due to the structural complexity of flavonoids





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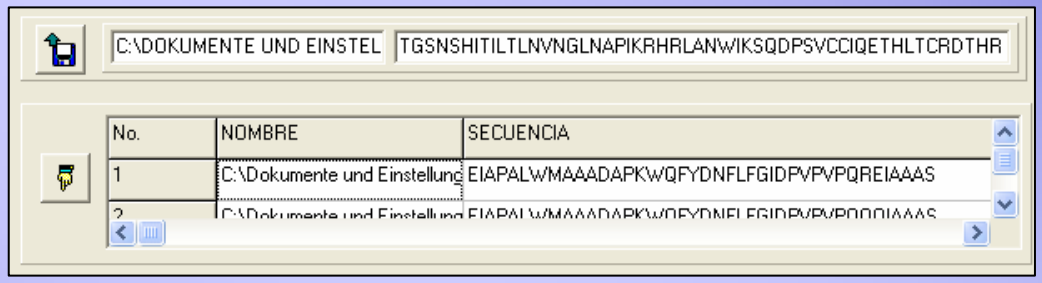
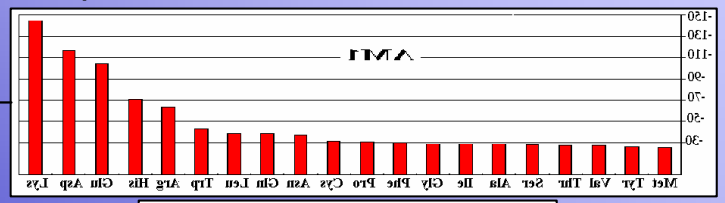
Application to biological systems

I.- *Exploration* (preparation of the data base)



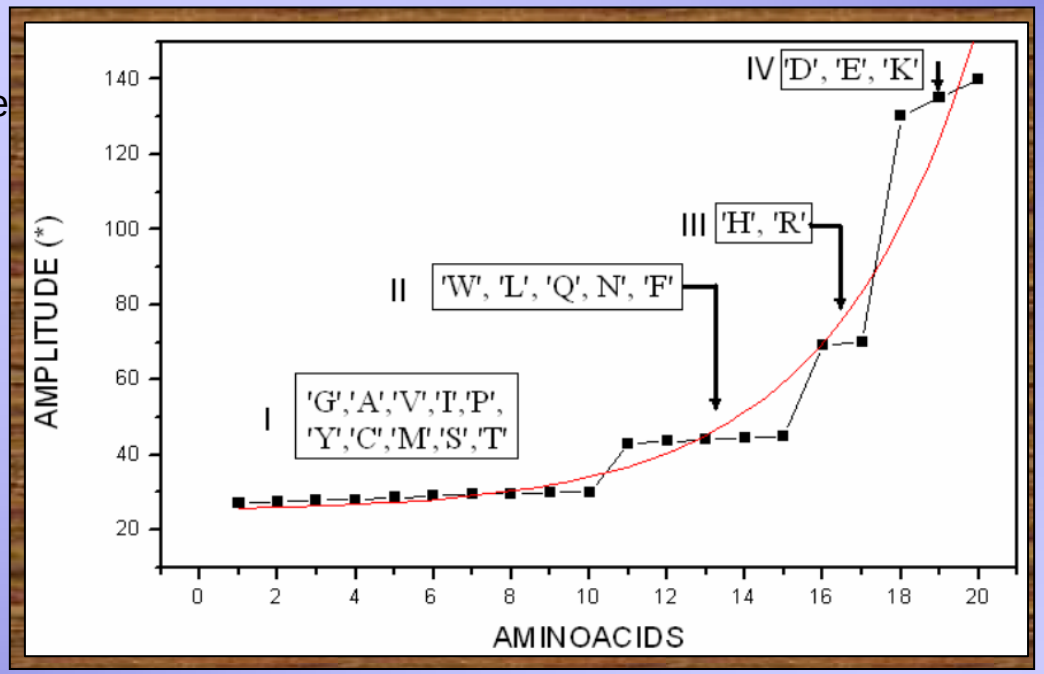
II.- *Classification Groups*

(Conformation of the Signal according with the exponential fit.



$$f(x) = Y + Ae^{\frac{x}{t}}$$

Y_0 = 24,85165, A=0,65219, t=3,78043



REPORT THE **AFINITY ORDER** OF THE INTERACTION

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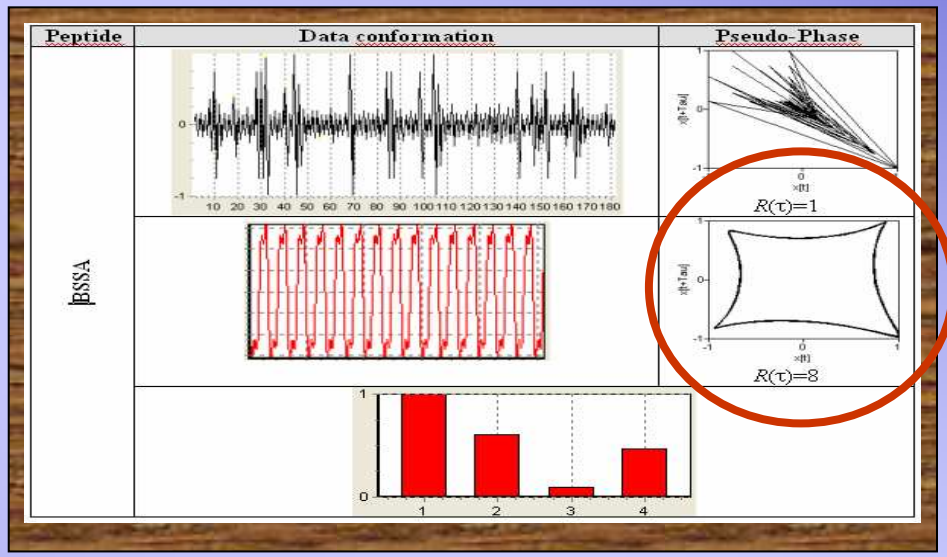
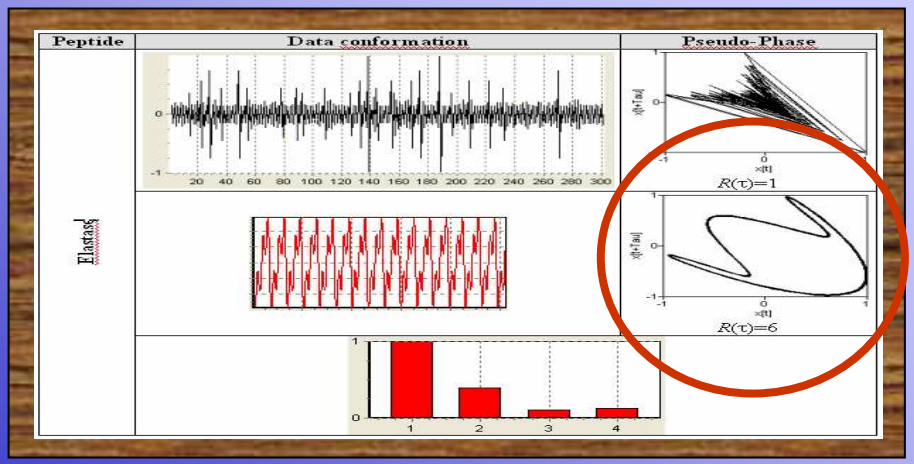
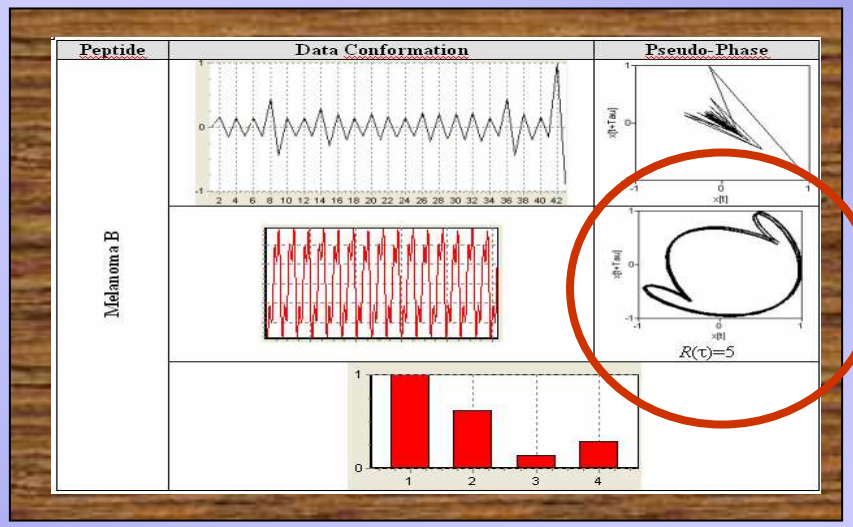
Application to biological systems. TEP







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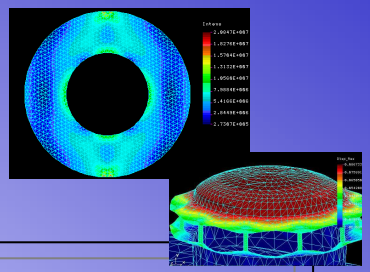
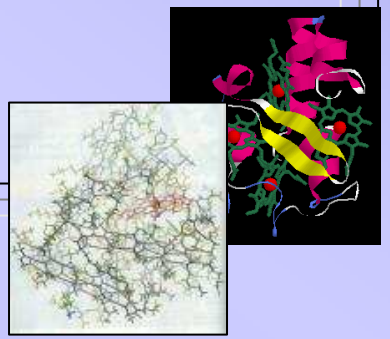
Next STEPS

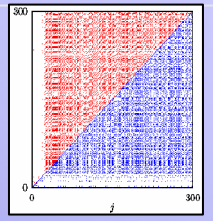


The high sensitivity of the PPP was demonstrated….

- **Structural modeling (PPP→pattern of MV)**
- **Application of the PPP as a pattern, considering**

  REAL STRUCTURE of the protein
- **Application of MDA (PDB)- RPQ**





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http://www.mpipks-dresden.mpg.de/~tisean/TISEAN_2.1/docs/chaospaper/node14.html