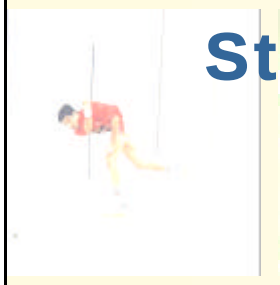
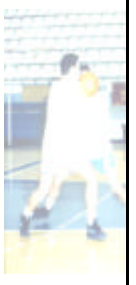
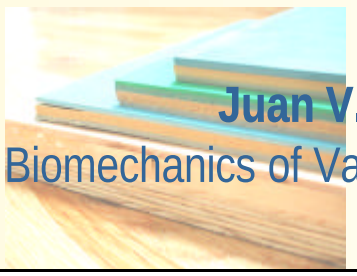
The shock absorption property

Standard & Biomechanics







Juan V. Durá
Institute of Biomechanics of Valencia

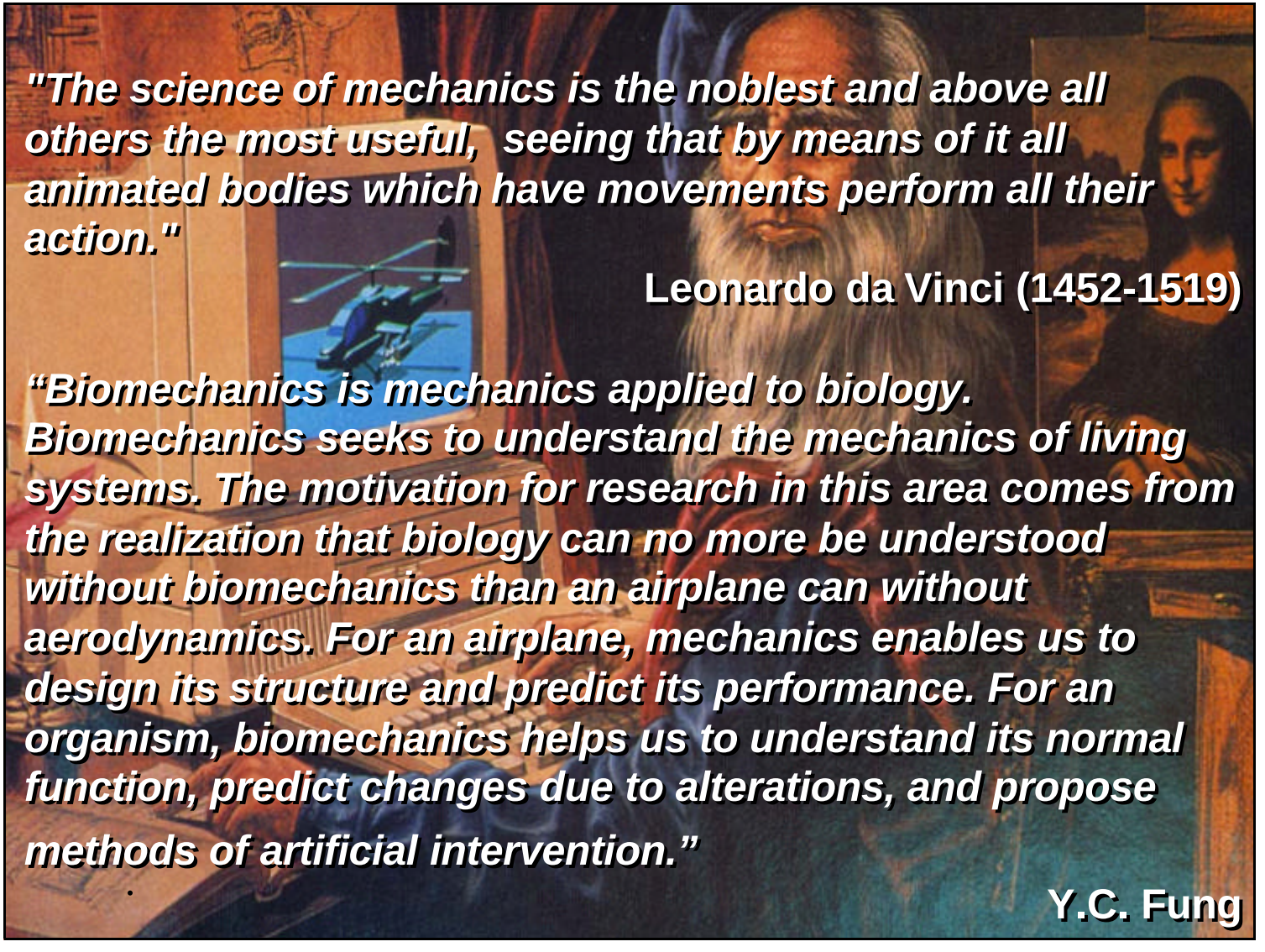
IBV INSTITUTO DE BIOMECÁNICA DE VALENCIA

The Institute of Biomechanics of Valencia (IBV)

IBV is a Research and Development (R&D) centre. Its objective is the promotion and practice of scientific research, technological development, technical assessment and training of qualified personnel.

Created in 1976, it is sponsored both by the Institute for Medium and Small Industries of Valencia (IMPIVA) and the Polytechnic of Valencia (UPV).

In 1994 it became a Non Profit Association constituted by public and private entities interested in the development of Biomechanics in service of the social, industrial and economic interests in our environment.


"The science of mechanics is the noblest and above all others the most useful, seeing that by means of it all animated bodies which have movements perform all their action."
Leonardo da Vinci (1452-1519)
“Biomechanics is mechanics applied to biology. Biomechanics seeks to understand the mechanics of living systems. The motivation for research in this area comes from the realization that biology can no more be understood without biomechanics than an airplane can without aerodynamics. For an airplane, mechanics enables us to design its structure and predict its performance. For an organism, biomechanics helps us to understand its normal function, predict changes due to alterations, and propose methods of artificial intervention.”
Y.C. Fung

Fields of Research: Groups and Sections

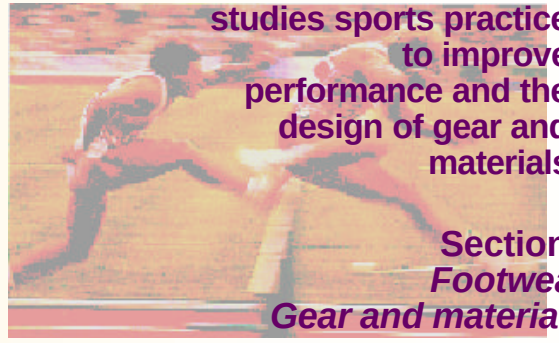
ORTHOPAEDIC BIOMECHANICS

analyses the pathologies which affect the human body in order to generate solutions.

Sections
Technical Aids
Orthopaedic Implants

SPORTS BIOMECHANICS

studies sports practice to improve performance and the design of gear and materials



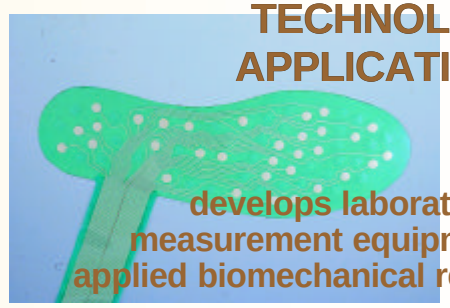
Sections
Footwear
Gear and materials

OCCUPATIONAL BIOMECHANICS

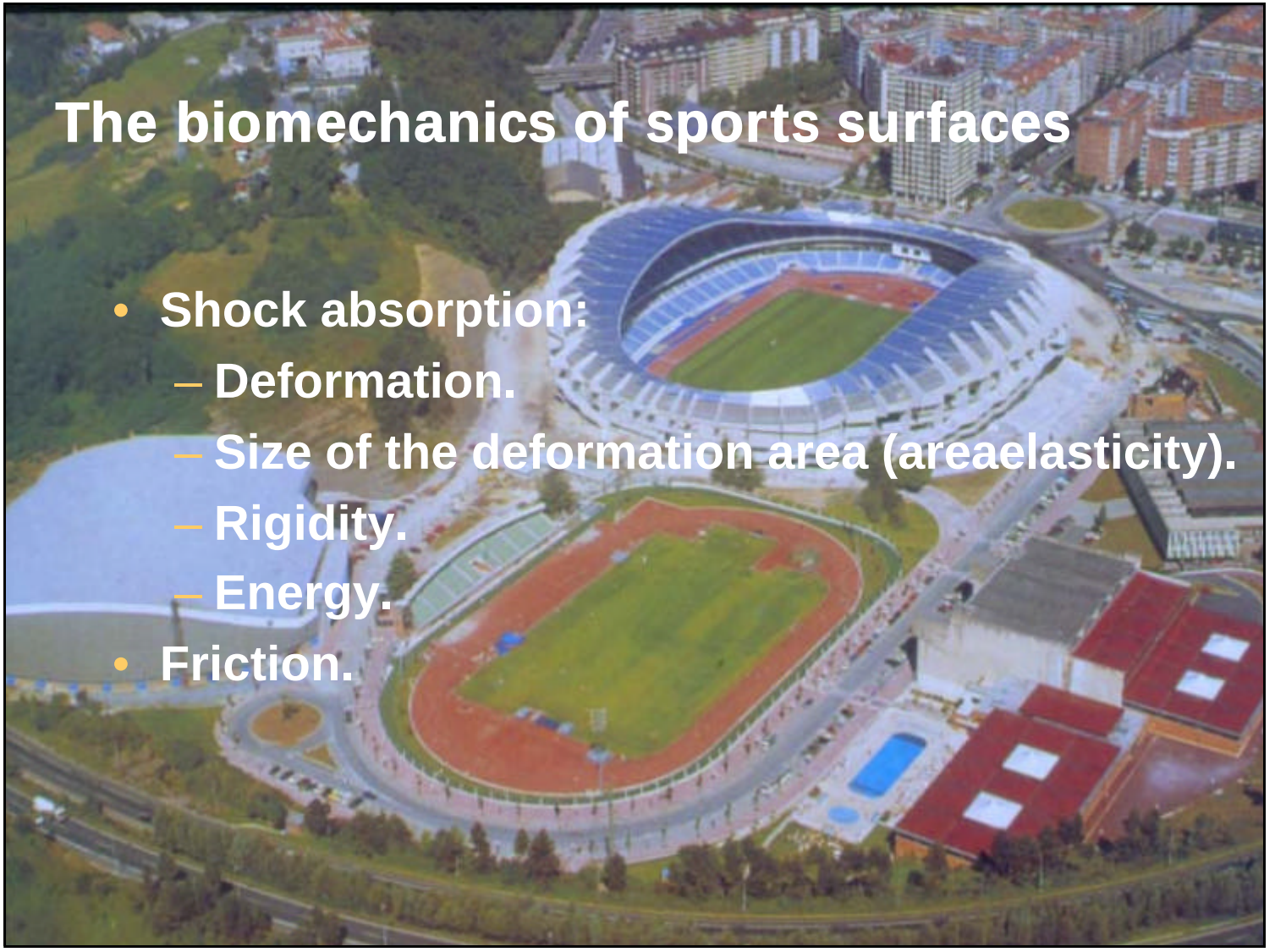
analyses the mechanical relationship between the human body and interacting elements

Sections
Furniture
Ergonomics of the workplace

TECHNOLOGY APPLICATIONS



develops laboratory and measurement equipment for applied biomechanical research

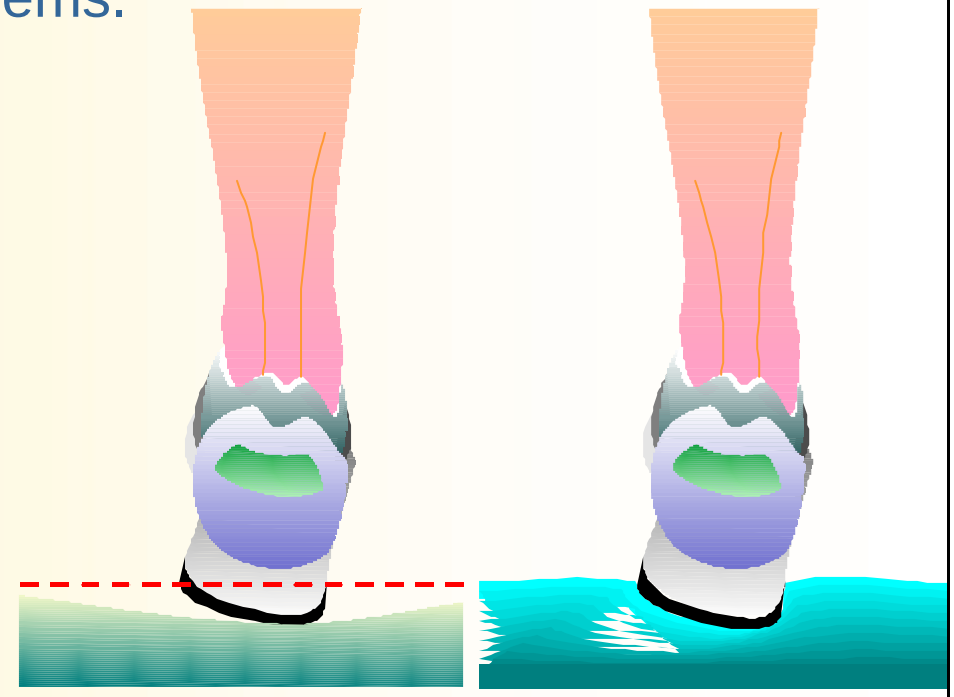


The biomechanics of sports surfaces

- Shock absorption:
  - Deformation.
  - Size of the deformation area (areaelasticity).
  - Rigidity.
  - Energy.
- Friction.

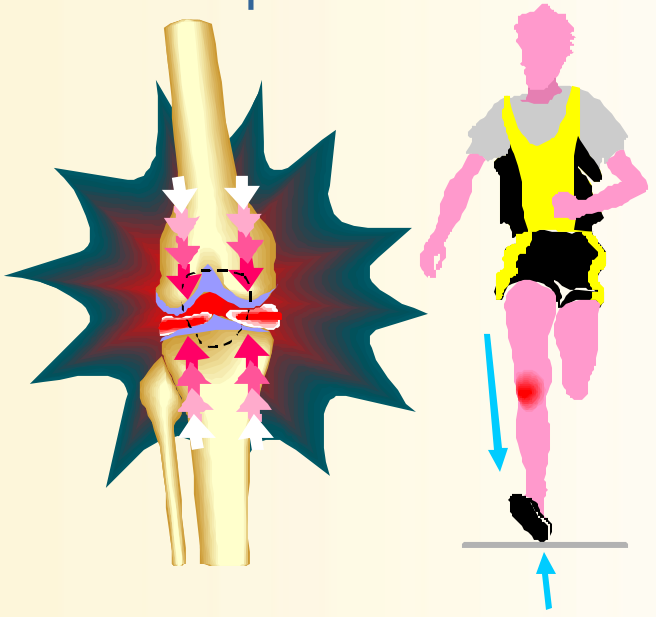
Deformation

- Stability problems.
- Foot fixation.



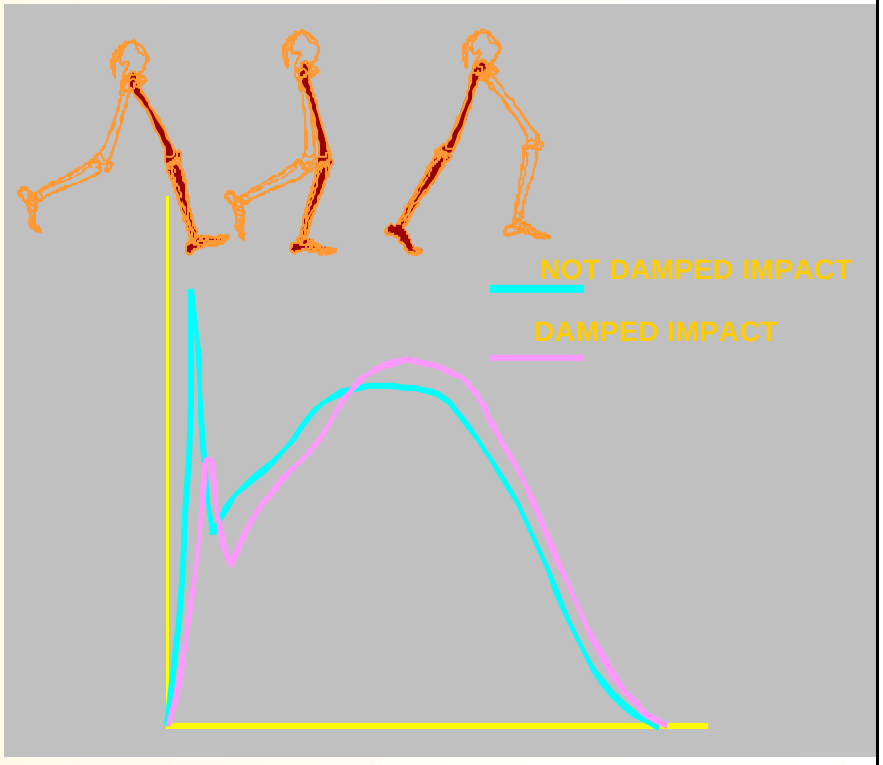
Shock absorption

- Impact: force peak, high force applied in a short time period.

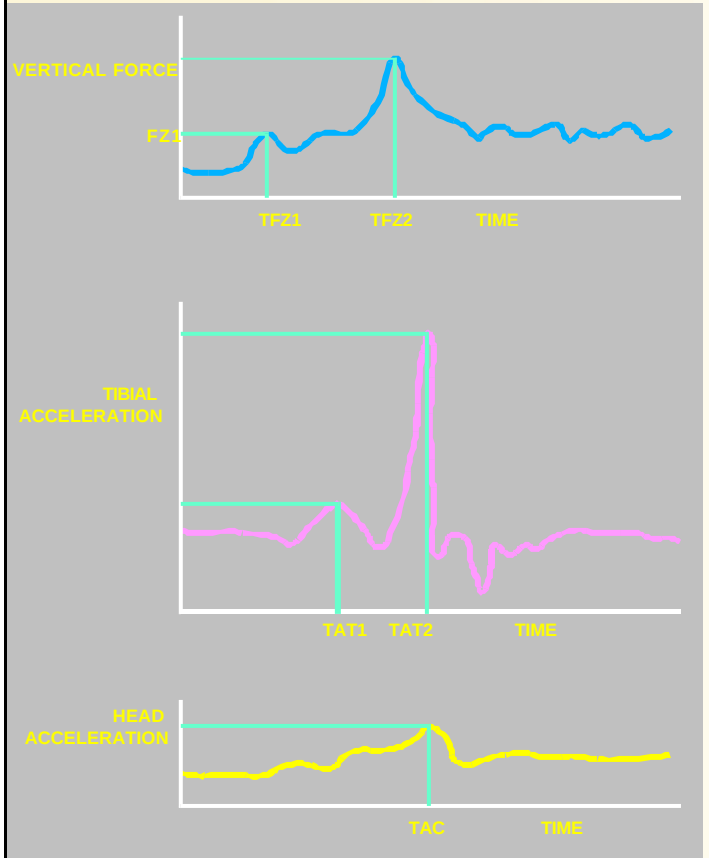


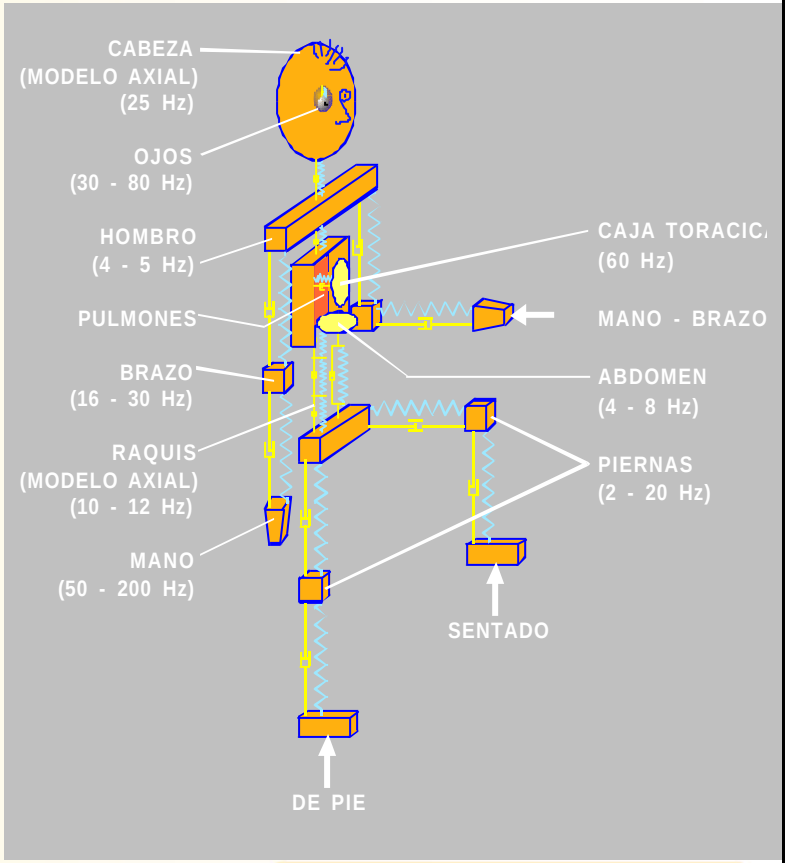
Impact protection

- To eliminate high frequencies.
- To reduce forces.



The impact transmission





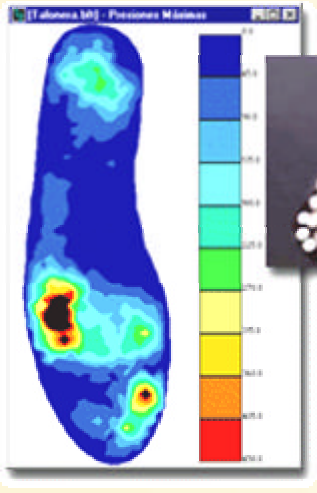
Biomechanical tests

- Accelerometers: impacts.

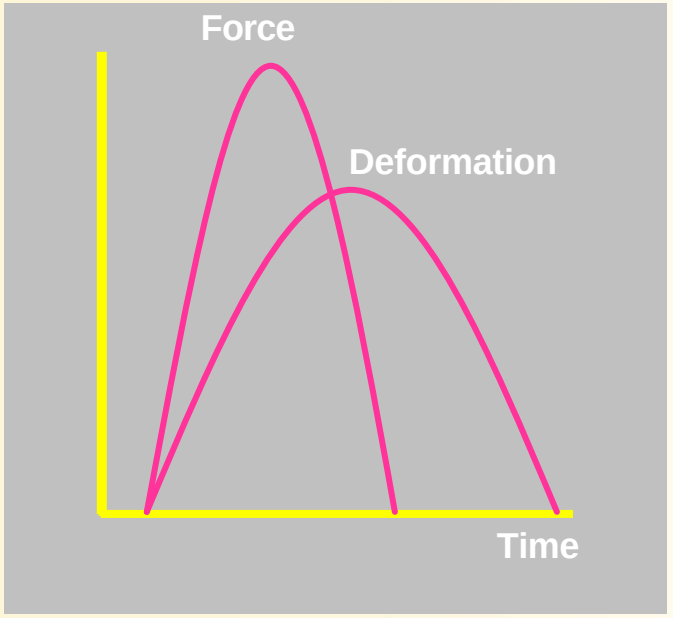
Biomechanical tests: analysis of movement

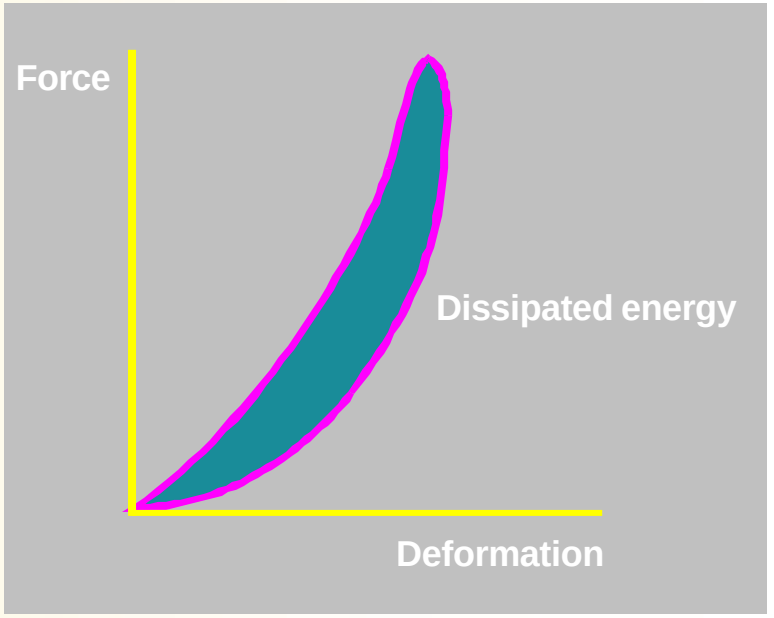
- Video: joint angles, velocities.
- Force platforms: forces over the surface.

Biomechanical tests: pressure



Viscoelastic behaviour

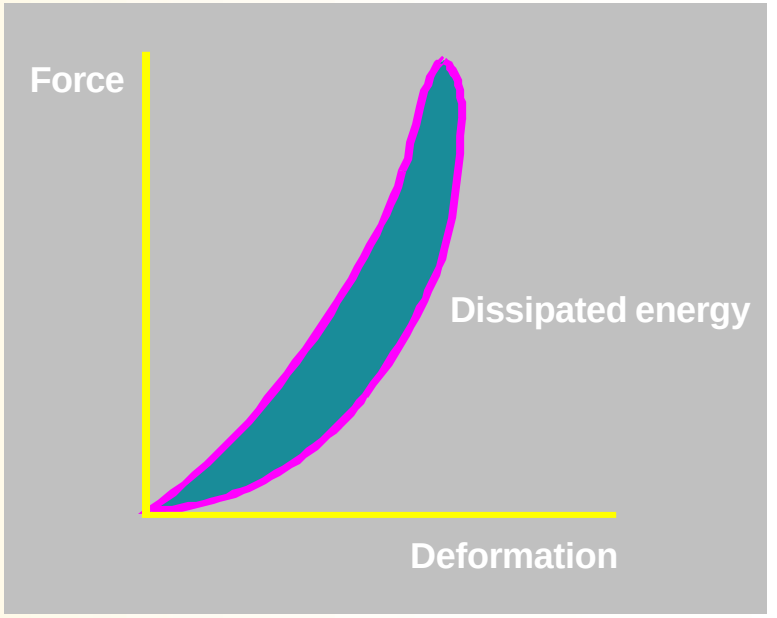




Viscoelastic behaviour

Will change with:

- Impact velocity.
- Maximum force.



Viscoelastic behaviour

- The sportsmen are able to protect themselves if the impact lasts less than 30 milliseconds.
- Most of the materials are more rigid when the impacts are faster.

The shock absorption must be tested with fast impacts.

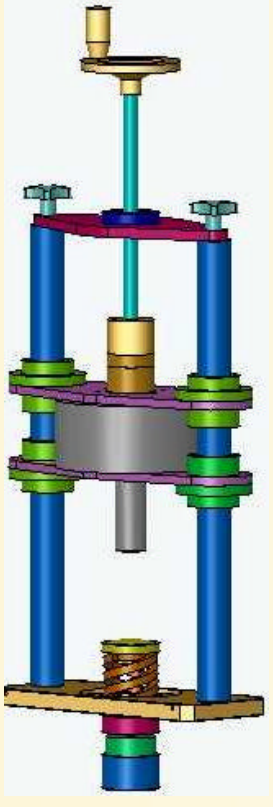
Mechanical tests

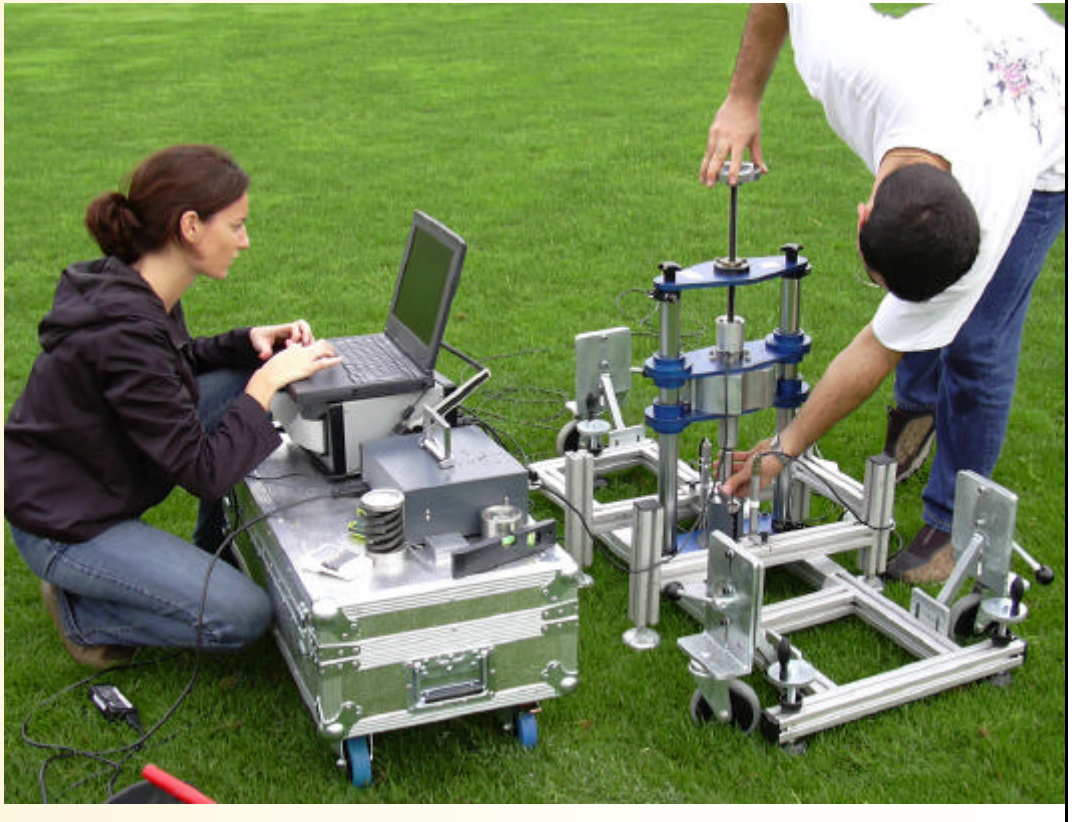
- Different mechanical testing devices and parameters have been used. But there are doubts about their capability for measuring the effect in athletes.
  - Drop tests.
  - Artificial athletes.

Drop tests

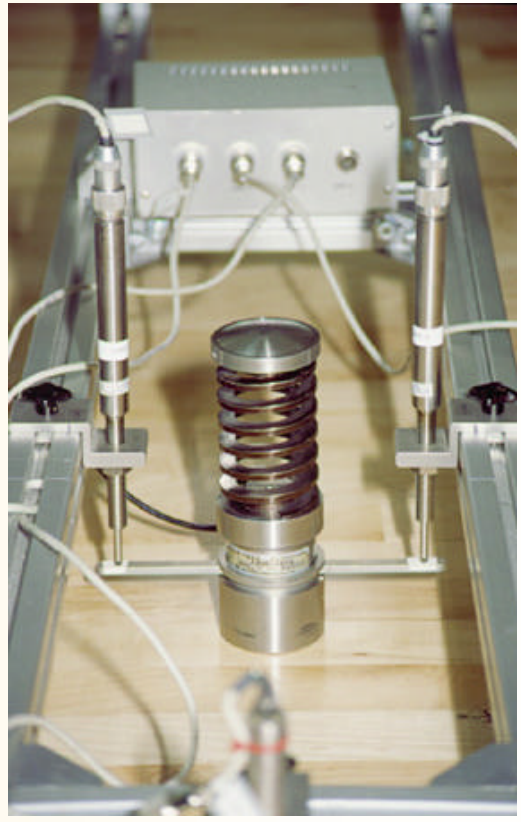
- Protection against falls: head injuries.

Artificial Athlete

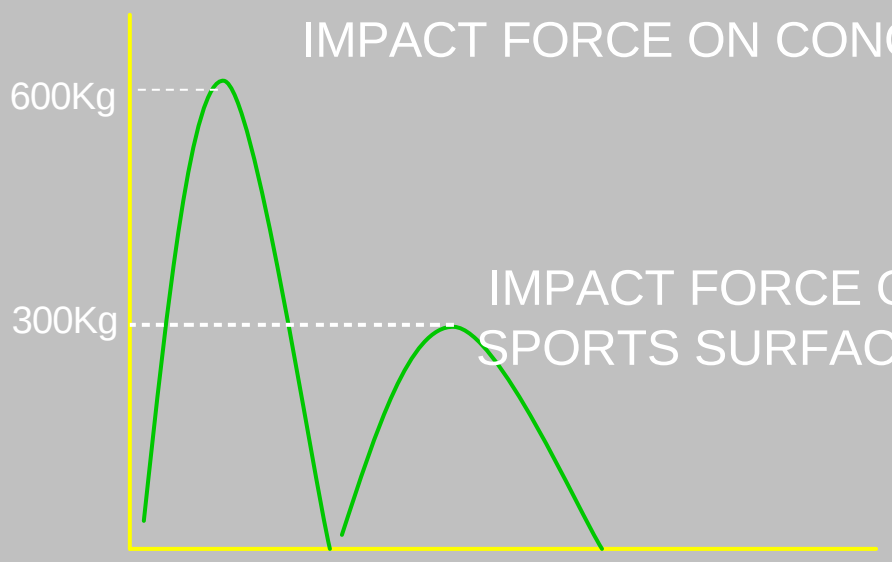




Artificial Athlete

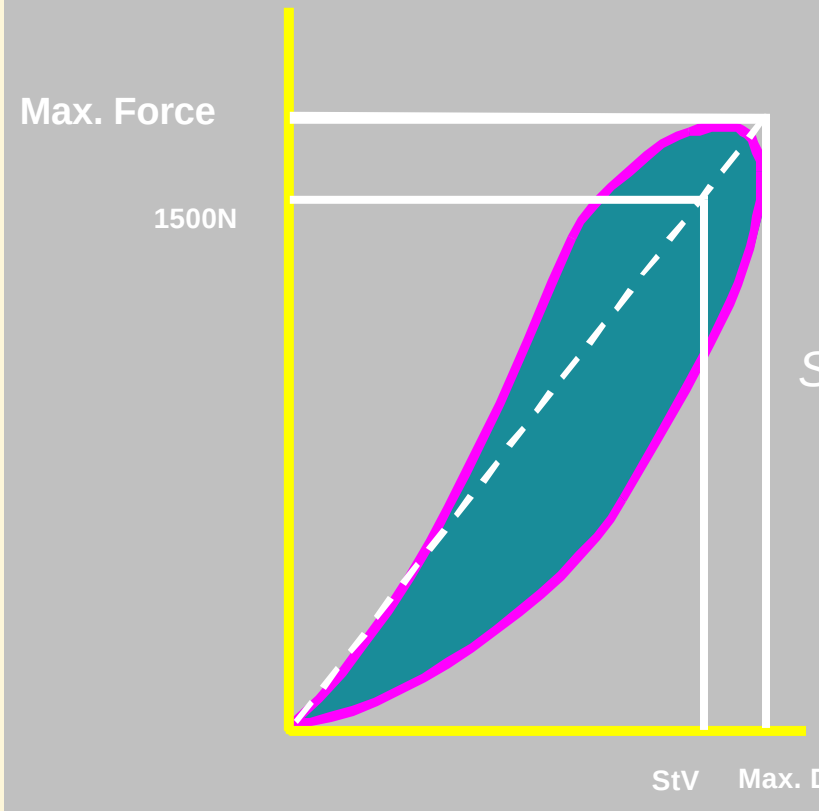


Shock Absorption



$$\text{Force Reduction} = 100 * \left(1 - \frac{\text{Force on sports surface}}{\text{Force on concrete}} \right)$$

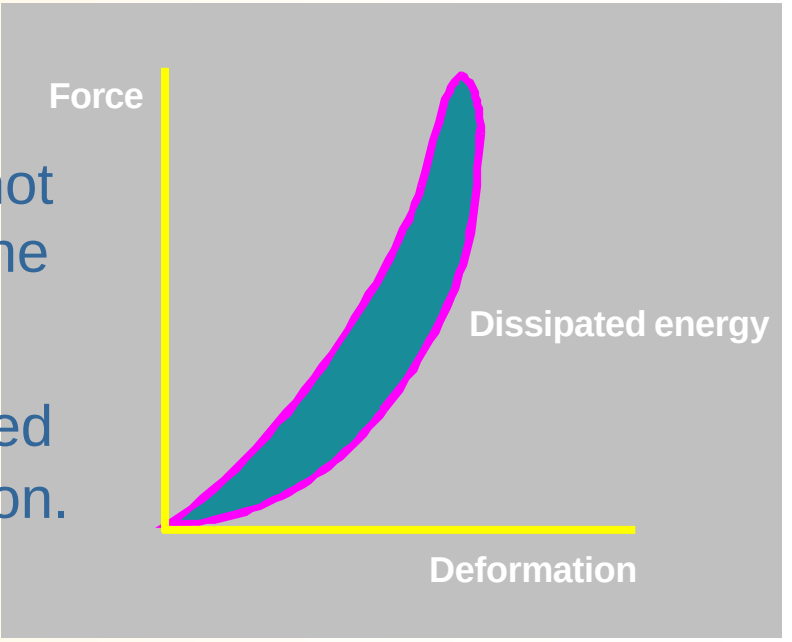
Standard vertical deformation



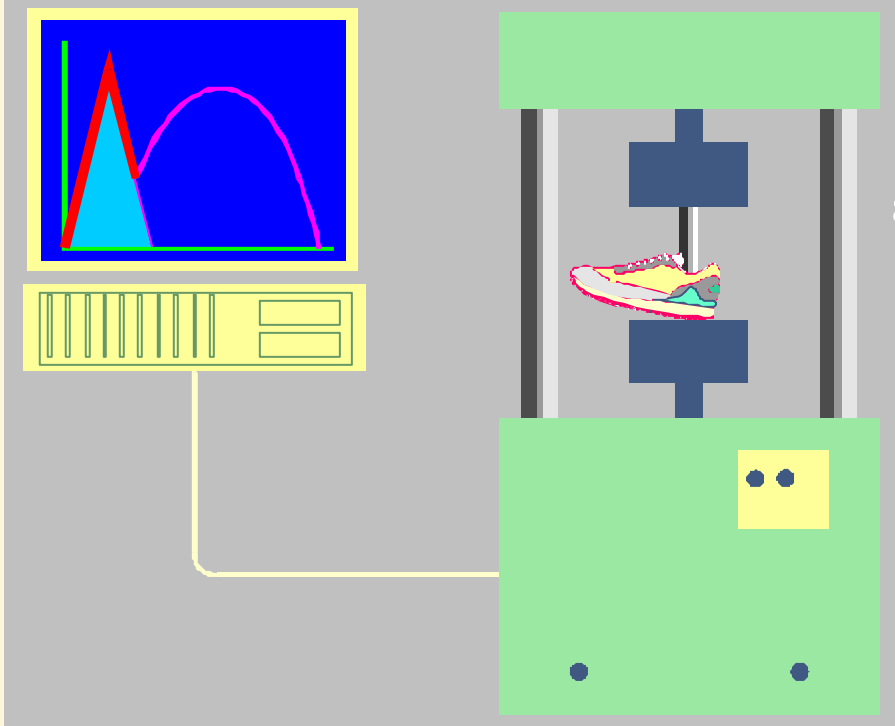
$$Stv = 1500 * \frac{Max.Deformation}{Max.Force}$$

Disadvantages of Artificial athlete

- Force reduction is not enough to explain the shock absorption.
- Energy is also related with shock absorption.



IBV test for shock absorbing materials



VISCOELASTIC MODEL

$$\sigma = \sigma_0(w)\,\sin(wt)$$

$$\varepsilon = \varepsilon_0(w)\,\sin(wt - \partial(w))$$

Dynamic Rigidity

$$|G| = \frac{\sigma_0(w)}{\varepsilon_0(w)}$$

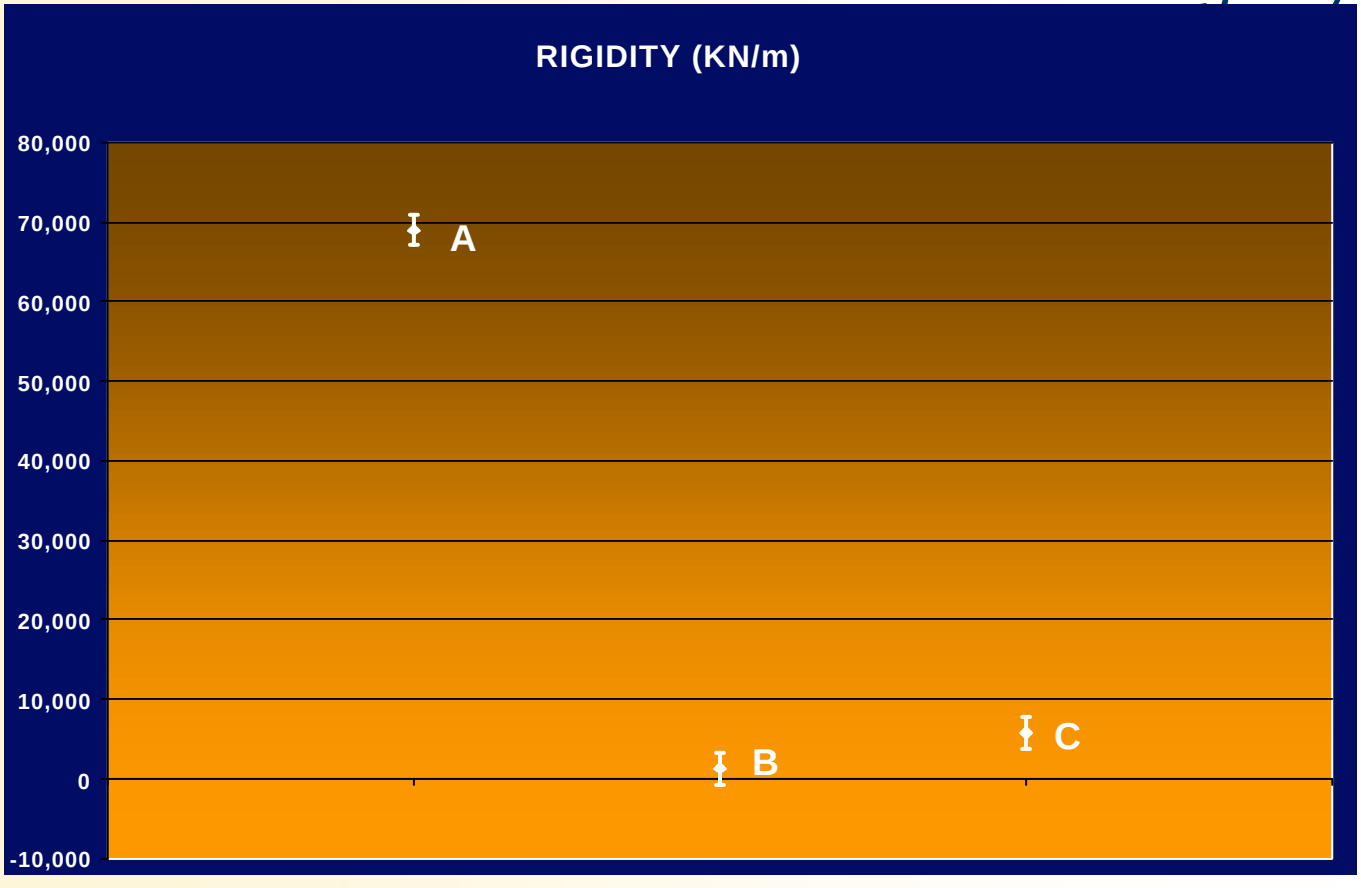
Loss tangent

$$\tan(\partial(w))$$

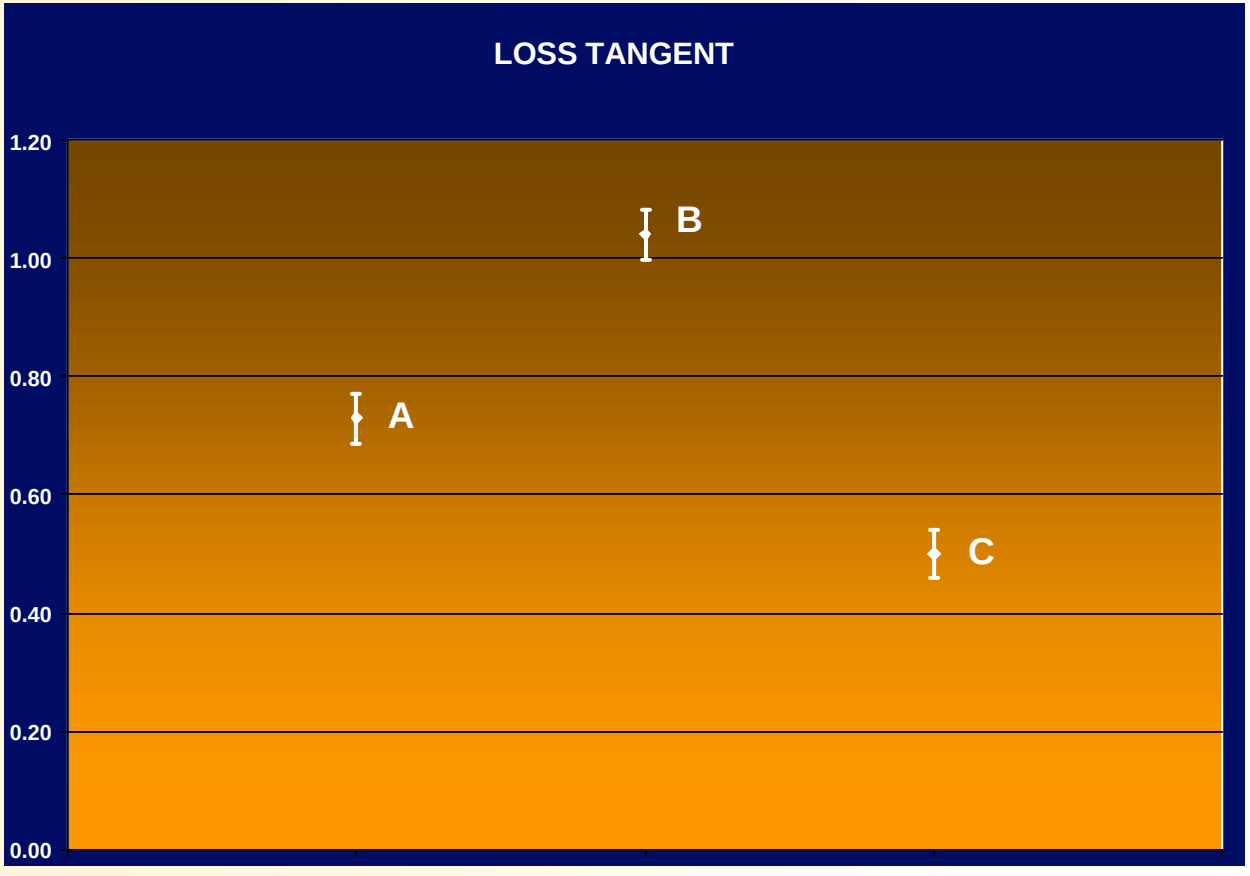
Example

MATERIAL		RF %
A.	PVC 6mm thick	19%
B.	Synthetic rubber 13mm thick	37%
C.	Synthetic rubber 6.5mm thick	20%

Rigidity

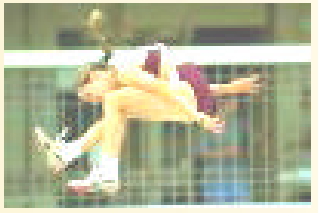

RIGIDITY (KN/m)
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
-10,000
A
B
C

Loss tangent



Protection vs. Performance

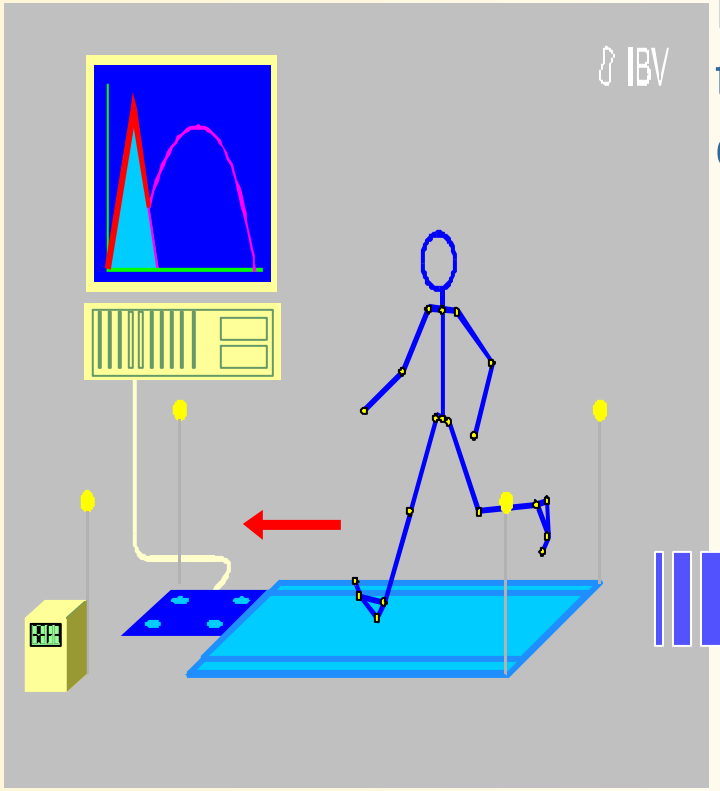
Is it possible to protect the athletes and to improve their performance?

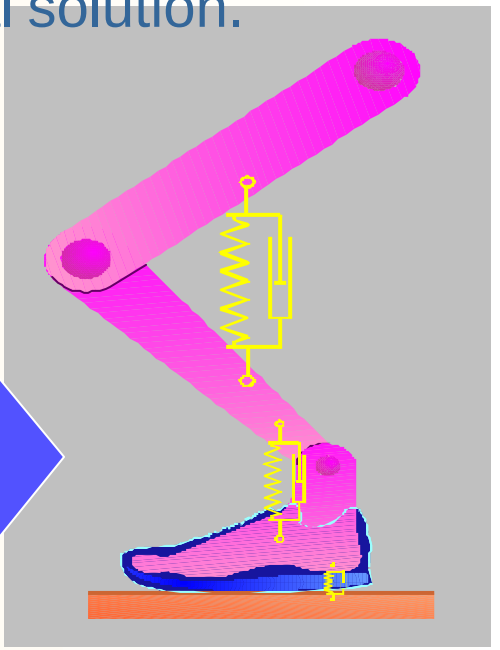


Is there an ideal sport surface?

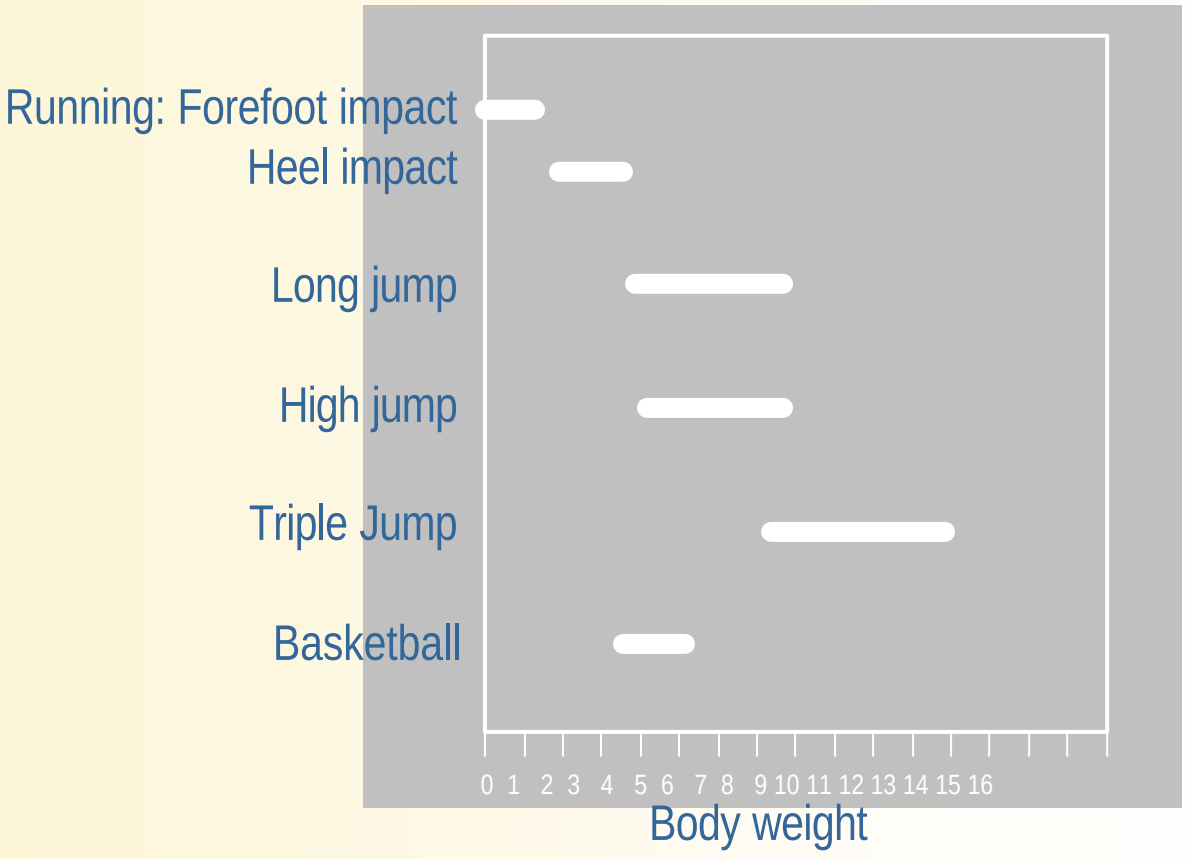
Protection vs. Performance

Biomechanics has proven the possibility of finding an optimal solution.





Problem: multisport surface



Advantages of Artificial athlete

- Simulation of fast impacts, the most dangerous for the athletes.
- The same machine is used for laboratory tests and on site tests.
- Reproducibility: ±2.
- Force reduction is related with the shock absorption.

IBV

Thanks for your attention